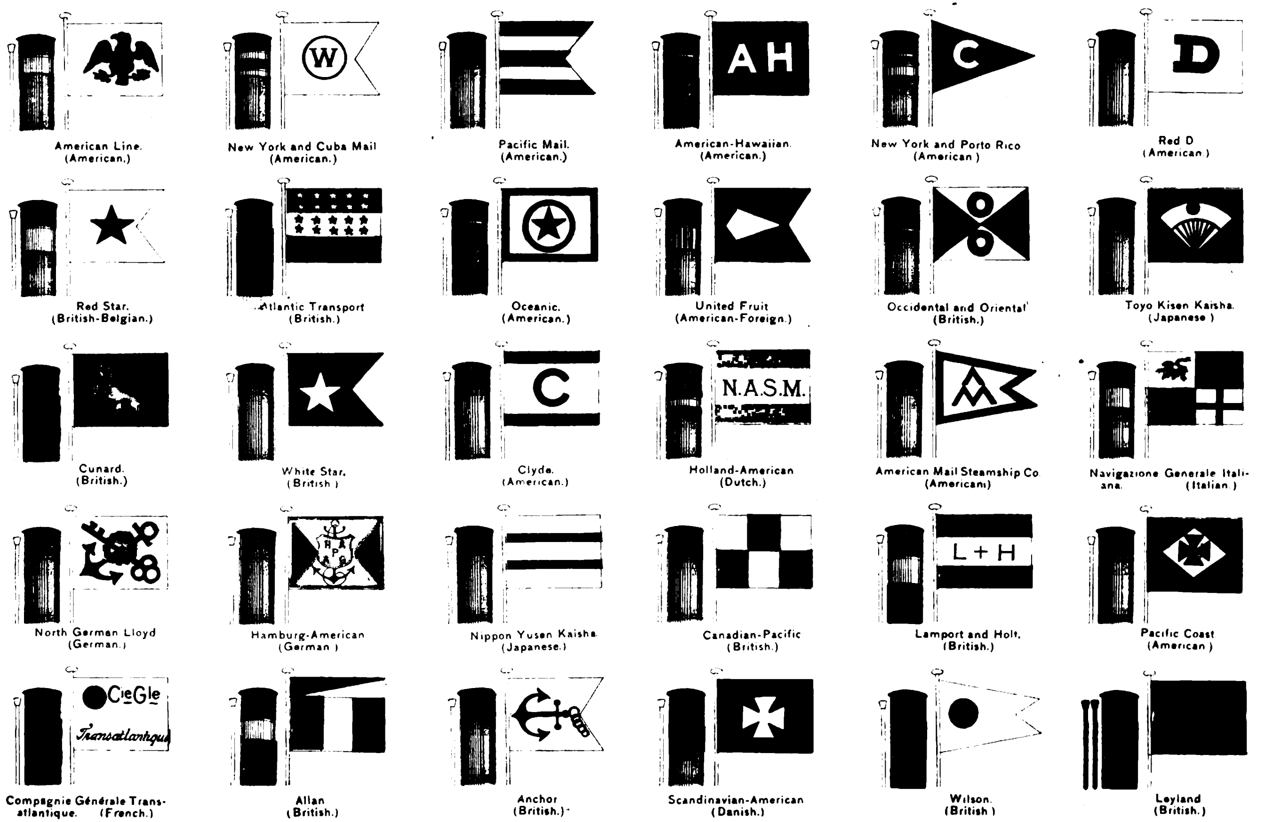
SCIENTIFIC AMERICAN REFERENCE BOOK



FUNNELS AND HOUSE FLAGS OF SOME PRINCIPAL STEAMSHIP LINES IN AMERICAN TRADE.

Scientific American Reference Book

Compiled by

Albert A. Hopkins
and
A. Russell Bond

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1905

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PREFACE.

THE Editor of the SCIENTIFIC AMERICAN receives during the year thousands of inquiries from readers and correspondents covering a wide range of topics. The information sought for, in many cases, can not readily be found in any available reference or text-book. It has been decided, therefore, to prepare a work which shall be comprehensive in character and which shall contain a mass of information not readily procured elsewhere. The very wide range of topics covered in the SCIENTIFIC AMERICAN REFERENCE BOOK may be inferred by examining the index and table of contents. This work has been made as non-technical as the subjects treated of will admit, and is intended as a ready reference book for the home and the office. It is possible that in some of the tables published in the book certain inconsistencies may be observed. Such a condition of affairs is in some cases inevitable. In procuring the figures, for example, from different Departments of the Government, with reference to any subject, it has been found that statistics vary in certain particulars. These variations are due to the different methods of tabulation, or to some different system by means of which the figures have been arrived at. In a number of cases these discrepancies will be noted in the book, but they are not to be regarded as errors.

The debt for advice and help has been a heavy one. The compilation of this book would have been impossible without the cordial cooperation of government officials, who have been most kind. Our thanks are especially due to the Hon. O. P. Austin, Chief of the Bureau of Statistics, Department of Commerce and Labor; to the Hon. S. N. D. North, Director of the Census; Prof. John C. Monaghan, Editor of the Consular Reports; Hon. Eugene Tyler Chamberlain, Commissioner Bureau of Navigation; Dr. Marcus Benjamin, of the Smithsonian Institution; Major W. D. Beach, U. S. A., of the General Staff; Rear-Admiral Charles O'Neil, late Chief of Bureau of

Ordnance, U. S. N.; Hon. S. I. Kimball, General Superintendent, Life Saving Service; the Director of the Mint, Capt. Seaton Schroeder, U. S. N., Chief Intelligence Officer, U. S. N.; many examiners in the Patent Office; Hon. Willis L. Moore, Chief of the Weather Bureau; many officials of the Agricultural Department; Hon. Carroll D. Wright, Commissioner Bureau of Labor; Hon. George M. Bowers, and Mr. A. B. Alexander, of the Bureau of Fisheries; Prof. Charles Baskerville, Ph.D.; Edward W. Byrn, of Washington; Dr. George F. Kunz, Hon. S. W. Stratton, of the Bureau of Standards, and many others.

We are also indebted to the J. B. Lippincott Co. for permission to use diagrams of Geometrical Constructions; to Hazell's Annual, Whittaker's Almanac, and the "Daily Mail Year Book." A number of our diagrams are from the "Universal-Taschen Atlas" of Prof A. L. Hichmann. Our matter on the "Arctic Regions" is translated from Dr. Hermann Haack's "Geographen-Kalender." For a number of our tables we must thank the excellent pocket books of D. K. Clark and Philip R. Bjorling, and we are also indebted to the Year Book issued by our esteemed English contemporary "Knowledge."

It is hoped that this work will save many fruitless searches through works of reference, as the aim of the compilers has been to obtain matter which is not readily available elsewhere.

NEW YORK, October 15, 1904.

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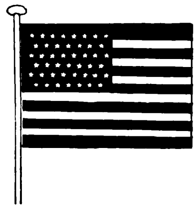
FLAG OF THE PRESIDENT.

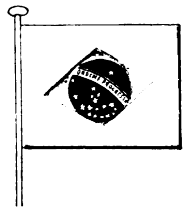


U. S. FLAG.

U. S. UNION JACK.

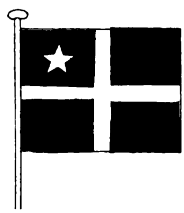
REVENUE FLAG.

BELGIUM.



BRAZIL.

CHILE.



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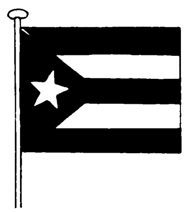


CUBA.

ECUADOR.

FRANCE.

AUSTRIA.–HUNGARY.

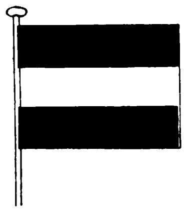
ARGENTINA.

CHINA.

COLOMBIA

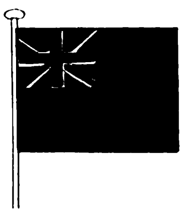
COSTA RICA.

DENMARK



GERMANY

GREAT BRITAIN.



ROYAL NAVAL RESERVE.
(WITH BADGE,
HOME AND COLONIAL GOVERNMENT DEPARTMENTS)

GREECE.

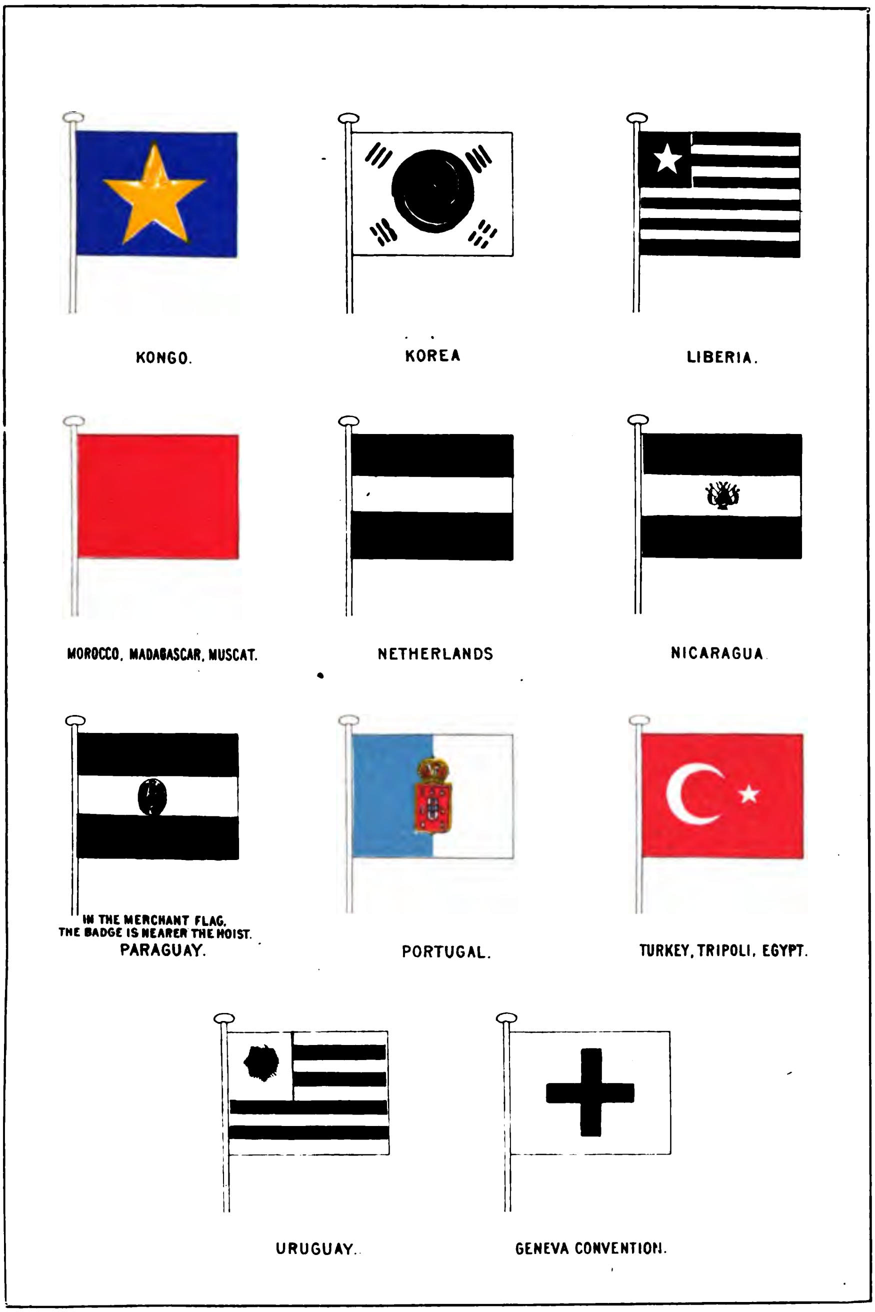
GUATEMALA.

HAITI

HONDURAS

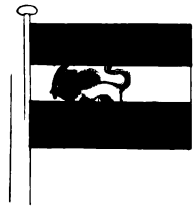
ITALY

JAPAN.


KONGO.
KOREA
LIBERIA.
MOROCCO, MADAGASCAR, MUSCAT.
NETHERLANDS
NICARAGUA
IN THE MERCHANT FLAG, THE BADGE IS NEARER THE HOIST.
PARAGUAY.
PORTUGAL.
TURKEY, TRIPOLI, EGYPT.
URUGUAY.
GENEVA CONVENTION.

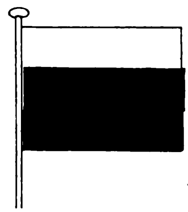

MEXICO.


NORWAY.


PERSIA.


PERU.


ROUMANIA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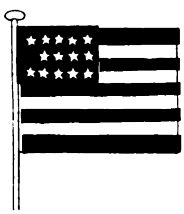
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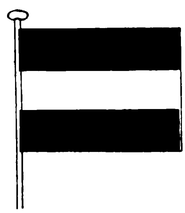
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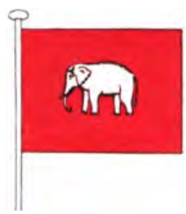
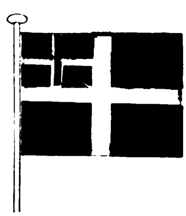

SIAM


SPAIN


SWEDEN

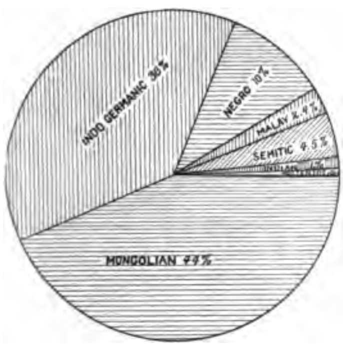

VENEZUELA.

CHAPTER I.

PROGRESS OF DISCOVERY.

DIVISIONS INTO RACES.

RACE.	*Location.*	*Number.*
Indo-Germanic or Aryan	Europe, Persia, India, etc.	545,500,000
Mongolian or Turanian	Greater Part of Asia	630,000,000
Semitic or Hamitic	North Africa, Arabia	65,000,000
Negro and Bantu	Central Africa	150,000,000
Hottentot and Bushman	South Africa	150,000
Malay and Polynesian	Australia and Polynesia	35,000,000
American Indian	North and South America	15,000,000



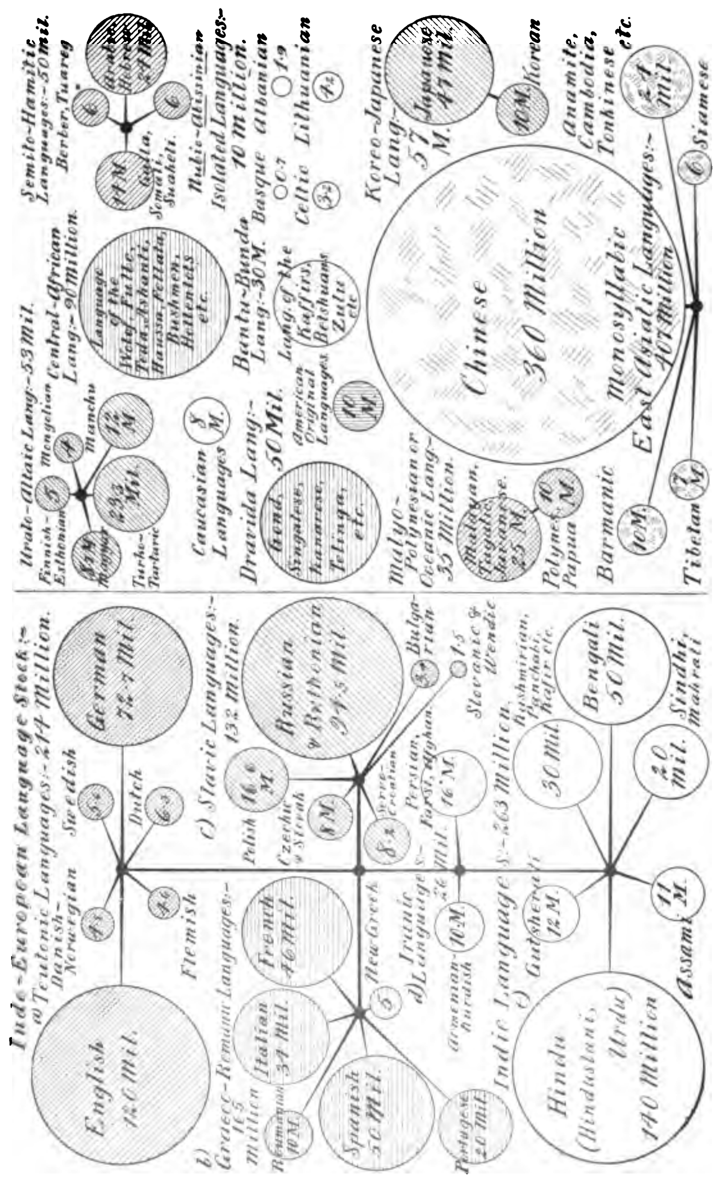
RACES OF MANKIND.

POINTS OF THE COMPASS.

TOTAL AREAS AND POPULATION OF THE EARTH.

	Square Miles.	*Square Kilometers.*	POPULATION. *In Thousands.*	*Per Square Mile.*	*Per Square Kilo.*
(1) Asia	17,071,999	44,216,523	820,768	48.0	18.5
(2) Europe	3,824,956	9,906,647	393,486	102.9	40.5
(3) Africa	11,506.785	29,802,603	180,321	15.6	6.2
(4) America	15,284,872	39,587,860	146,432	9.5	3.6
(5) Australia and Oceania	3,457,667	8,955,369	6,450	1.8	0.7
(6) Polar Regions	1,656,394	4,290,065	13	0.008	
Total	52,802.673	136,759,067	1,547,470	177.808	11.6

—*Hübner's Geographisch-Statistische Tabellen.*



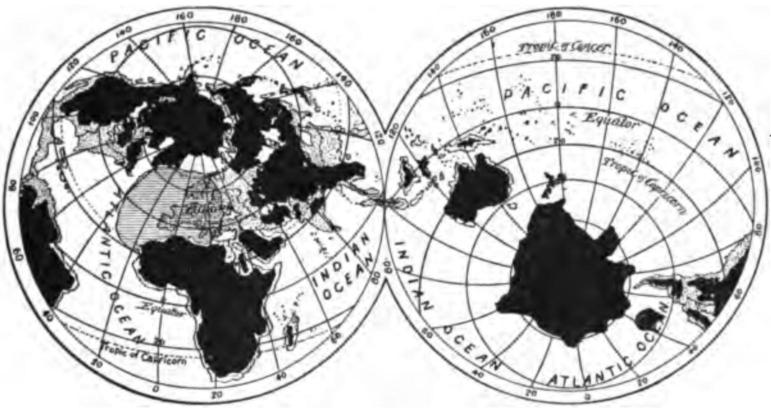
LANGUAGES OF THE WORLD.

THE PROGRESS OF DISCOVERY.

Date.	Explorer and Nationality.	Discovery or Exploration.
B.C.		
1400–1250	Egyptians.	Invasions of Habesh, Arabia, Phœnicia, Syria.
? 1350	Greeks.	Argonautic expedition to Colchis.
1000	Phœnicians.	Voyages to Ophir, Gades, Britain.
750	Greeks.	Extension of Colonies in the Mediterranean and Pontus Euxinus.
700	Samians.	Spain (Tartessus) discovered for the Greeks.
600	Phœnicians.	Circumnavigation of Africa by order of Necho.
500	Himilco (Carthag.).	Atlantic coasts of Europe. Sargasso Sea. Said to have visited Britain.
"	Anaximander (of Miletus).	Makes the first maps.
"	Hecatæus (of Miletus).	Writes the first geography.
470	Hanno (Carthag.).	West Africa as far as Cape Palmas.
330	Pytheas of Massilia.	? Thule, North Sea, Scandinavia.
"	Nearchus (Macedon.).	Sails from the Indus to Red Sea.
329–325	Alexander the Great.	Expedition to Iran, Turan, and India.
290	Egyptians.	Navigate the East coast of Africa.
218	Romans.	Hannibal crosses the Alps.
about 120	Eudoxus of Cyzicus.	Attempts circumnavigation of Africa.
61–58	Romans.	Julius Cæsar in Gaul, Germany, and Britain
since 30	Romans.	Extension of geographical knowledge and commerce as far as Central Asia.
20	Strabo (Greek).	Describes Roman Empire and first mentions Thule and Ireland.
15	Romans.	Tiberius discovers the Lake of Constance; Drusus, the Brenner Pass.
A.D.		
84	Romans.	Agricola circumnavigates Britain.
150	Claudius Ptolemy (Egypt.)	Constructs his Geography and Atlas.
518–21	Hoei-sing (Chinese).	Visits Pamirs and Punjab.
671–95	I-tsing (Chinese).	Visits Java, Sumatra, and India.
861	Norsemen.	Faroe Islands. North Cape of Europe rounded.
865	Naddod (Norse).	Discovers Iceland. Visited by Irish monks about 795.
876	Gunnbjörn (Norse).	Greenland coast. Rediscovered by Erik the Red (983).
985	Erik the Red (Norse).	Colonizes Greenland.
? 1000	Lyef Erikson (son of Erik the Red)	Discovers Newfoundland (Helluland), Nova Scotia (Markland), and coast of New England (Vinland)[?].
1154	Edrisi (Sicily).	Geographer to King of Sicily, produces his geography.
about 1200	Arabs.	Trading merchants discover Siberia.
1253	Ruysbroek.	Reaches Karakorum, the ancient seat of the Mongol Empire.
1271–95	Marco Polo (Venet.).	Travels in Central Asia, China, India, Persia.
1290	Genoese.	Canaries, Azores, etc.
1325–52	Ibn Batuta (Arab.).	Travels through the whole Mohammedan World, N. Africa, E. Africa, S. Russia, Arabia, India and China.
1327	Sir John Mandeville (Eng)	? Travels in India.
1415–60	Prince Henry (Port.).	Gives an impetus to Portuguese voyages of discovery.
1419–20	J. Gonzales and Martin Vaz (Port.).	Porto Santo and Madeira discovered.
1442	Nuno Tristao (Port.).	Cape Verde, etc.
? 1460	Cintra and Costa (Port.).	Coast of Guinea reached.
1474	Toscanelli (Ital.).	Sends Columbus his map showing the western route to Cathay (China).
1485	Diego Cam (Port.).	Mouth of the Congo reached.
1487	Bartholomew Diaz (Port.)	Rounds Cape of Good Hope.
1492–98	Columbus (Gen.).	America, West Indies, Trinidad, Cuba, etc.
1497–98	Giovanni Cabot (Anglo-Ven.).	Sails along E. coast of America from Labrador as far as Florida.
1498	Vasco da Gama (Port.).	Route to India by Cape of Good Hope.
1499	Amerigo Vespucci (Ital.).	Venezuela, and that America was not "part of Asia."
"	Pinzon (Span.).	Discovers mouth of R. Amazon and Cape St. Roque.
1500	G. Cortereal (Port.).	Reaches entrance of Hudson Strait, called by him Strait of Anian.
"	Alvarez Cabral (Port.).	Brazil (named by him Ilha da Vera Cruz, being S. part of Bahia State).
1502	Columbus (Gen.).	Central America on his fourth voyage.
1512	Ponce de Leon (Span.).	Florida.
1513	Portuguese.	Reach the Moluccas.

THE PROGRESS OF DISCOVERY—*Continued.*

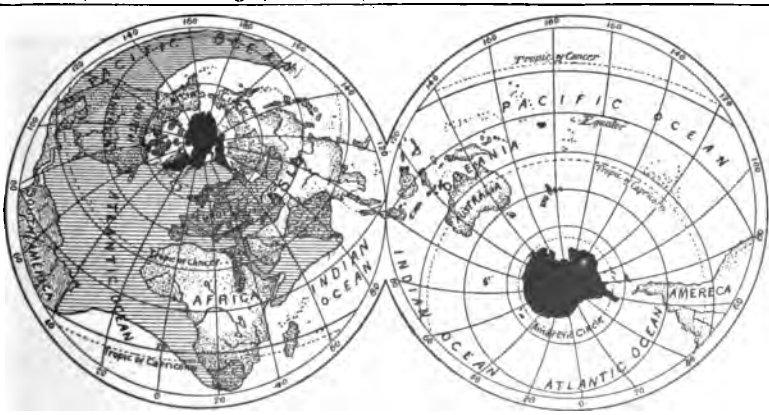
Date.	Explorer and Nationality.	Discovery or Exploration.
A.D. 1513	Balboa (Span.)	Crosses Isthmus of Panama and discovers Pacific Ocean.
1516	Solis (Span.)	Reaches La Plata.
1517	Sebastian Cabot (Eng.)	Hudson Strait.
1519–21	Cortez (Span.)	Conquest of Mexico.
1519–21	Magellan (Span.)	First to circumnavigate the globe. Passes through the Strait of Magellan, crosses the Pacific, and discovers the Philippines.
1534	Pizarro (Span.)	Completes the Conquest of Peru.
1535	Diego d'Almagro (Span.).	Conquers Chili.
1535–42	Jacques Cartier (Fr.)	Gulf of St. Lawrence. Ascends river to Hochelaga (Montreal).
1539	Francesco de Ulloa (Span.)	Explores Gulf of California.
about 1540	French	Continent of Australia seen by French sailors.
1541	Pizarro and Orellana (Span.)	Amazon River.
1542	Antonio de Mota	First reaches Japan.
"	Ruy Lopez de Villalobos (Span.)	Discovers Pelew Islands, and takes possession of Philippine Islands for Spain.
"	Pinto (Port.)	Visits Japan.
1553	Sir H. Willoughby (Eng.).	Novaia Zemlia.
1576	Frobisher (Eng.)	Labrador and Baffin Land.
1577–80	Sir F. Drake (Eng.)	Second circumnavigation of the globe, and first saw Cape Horn. Explored W. coast of N. America nearly as far as Vancouver Archipelago.
1587	J. Davis (Eng.)	Davis Strait.
1596	Barentz and Heemskerk (Dut.)	Spitzbergen, Bear Islands, etc.
1598	Mendaña (Span.)	Discovers Marquesas Islands.
1606	Quiros (Span.)	Tahiti (Sagittaria), and other South Sea Islands.
"	Torres (Span.)	Torres Strait. Dutch reach Australia.
1608	Champlain (French)	Discovers Lake Ontario.
1610	H. Hudson (Eng.)	Hudson Bay and discoveries in N. America.
1614–17	Spillbergen (Dut.)	Circumnavigation of the globe.
1616	W. Baffin (Eng.)	Enters Baffin Bay.
"	LeMaire and Schouten (Dut.)	Round Cape Horn.
"	Dirk Hartog (Dut.)	West coast of Australia.
1618	G. Thompson (Eng. mer.)	Sails up Gambia.
1642	Abel Tasman (Dut.)	Van Diemen's Land (Tasmania) and New Zealand.
1643	Vries (Dut.)	Explores E. coast Japan, Saghalien, and Kurile Is.
1645	Deshnev (Cossack)	Rounds East Cape of Asia from the Kolyma to the Anadyr.
1660	French	Lake region of the St. Lawrence discovered.
1673	Marquette and Joliet (Fr)	Exploration of the Mississippi from the north.
1725–43	Russians	Exploration of the coasts of Siberia.
1728 and '41	Bering (Dan.) and Tishirikov (Rus.)	Bering Strait and the NW. coast of America.
1764–66	Byron (Eng.)	Circumnavigation of the globe
1768–79	Capt. Cook (Eng.)	Voyages round the world. Hydrographical surveys of the Society Islands, Sandwich Islands, E. coast of Australia, Cook Strait in New Zealand, Antarctic Ocean, NW. coast of America, etc.
1770	James Bruce (Scot.)	Sources of the Blue Nile.
"	Liakhov (Russian)	Discovers New Siberian Islands.
1785–88	La Perouse (French)	North of Japan, Saghalien, etc.
1789	A. Mackenzie (Scot.)	Exploration of the Mackenzie River.
1792	Vancouver (Eng.)	Vancouver Island circumnavigated. Discovered by Perez, 1774. Exploration of NW. coast of America.
1795–1806	Mungo Park (Scot.)	Journeys and explorations in the Niger districts.
1799–1804	Alex. von Humboldt (Ger.)	Explorations in South America and "Cosmos."
1801–1804	Flinders (Eng.)	Southern coasts of Australia.
1803–6	Krusenstern (Rus)	Surveys in Sea of Japan and Sea of Okhotsk, Saghalien, etc.
1805–9	Salt (Eng.)	Visit to Abyssinia
1807–8	Klaproth (Ger.)	Exploration of the Caucasus.
1819	Sir E. Parry (Eng.)	Parry Archipelago.
" 1825	Sir J. Franklin, Richardson and Back (Eng.)	Coppermine and Mackenzie Rivers explored.
1819	Long (U. S.)	Exploration of Rocky Mountains



THE UNKNOWN WORLD, 1800.

THE PROGRESS OF DISCOVERY—*Continued.*

Date.	Explorer and Nationality.	Discovery or Exploration.
1819	Wm. Smith (Eng.).......	South Orkney Islands and South Shetlands. Visited by Weddell in 1822.
1823	Wrangel (Rus.).........	Discovers Wrangel Land.
1823	Denham and Clapperton (Eng.)............	Lake Chad.
1825–26	A. G. Laing (Scot.)......	Reached Timbuktu from Tripoli.
1827–8	René Caillie (French)....	Journey from Kakandy to Timbuktu and Morocco.
1829	Sturt (Eng.)...........	Descends the Murrumbidgee and discovers the Murray River.
1830–32	Biscoe (Eng.)...........	Enderby Land and Graham Land.
1830	....	Royal Geographical Society founded in London.
1831	Sir J. C. Ross (Eng.).....	Magnetic North Pole.
1832	Laird and Oldfield (Scot.).	Exploration of the Niger and Benué.
1833–35	Sir G. Back (Eng.)	Great Fish River.
1835	Sir F. Schomburgk (Ger.).	Explorations in Guiana.



THE UNKNOWN WORLD, 1900.

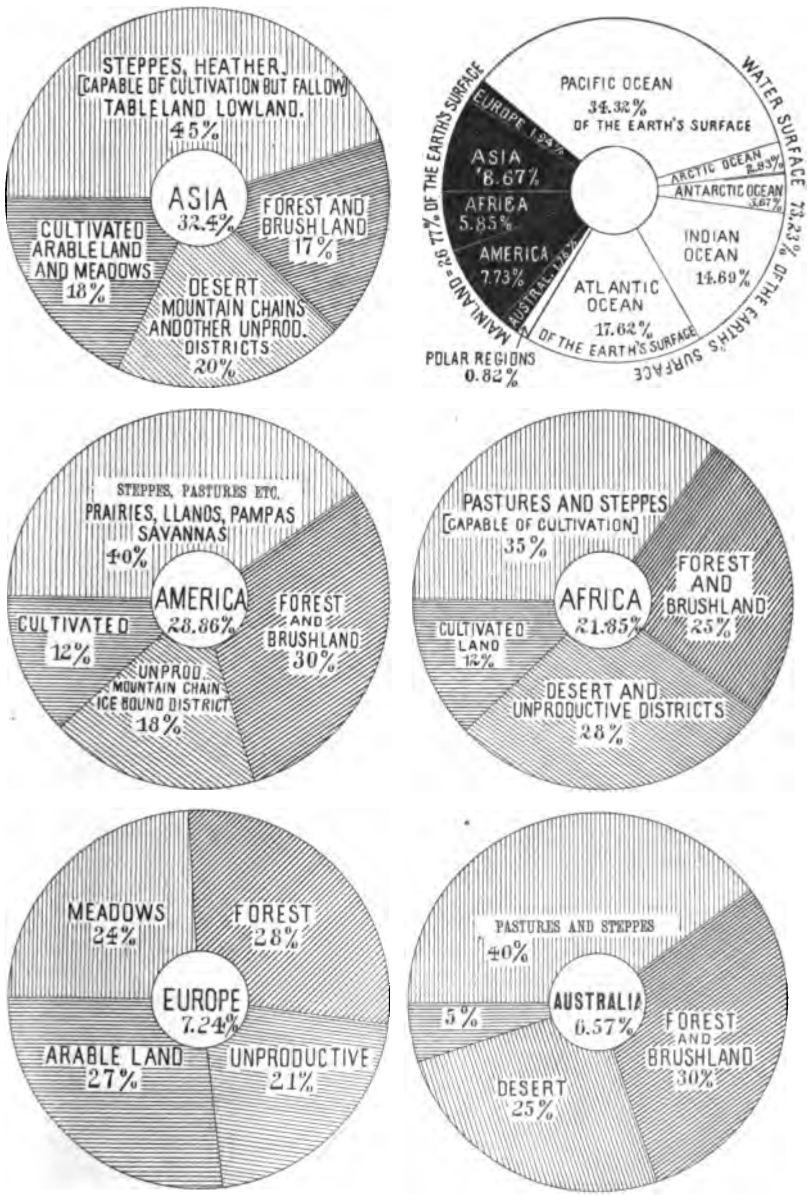
The black areas are unexplored.

The shaded portion represents the radius of a three weeks' journey from London in 1800 and 1900. —*Bartholomew's Atlas.*

THE PROGRESS OF DISCOVERY—*Continued.*

Date.	Explorer and Nationality.	Discovery or Exploration.
1837	Wood (Eng.)	Sources of the Oxus.
1837–40	D'Urville (French)	Adélie Land. Reached 66° 30′ S. lat.
1839	J. Balleny (Eng.)	Balleny Islands, 66° 44′ S. lat.
1839	Eyre (Eng.)	Discovers Lake Torrens, S. Australia, and in 1841 journeys from Adelaide to King George's Sound.
1840	Trümmer	Remains of ancient Nineveh.
1841	Sir James C. Ross (Eng.)	Victoria Land, with volcanoes Erebus and Terror.
1841–73	D. Livingstone (Scot.)	Thirty years' travel in Central South Africa.
1844–45	Leichhardt (Ger.)	Crosses Australia, Moreton Bay to Port Essington.
1845	Sir John Franklin (Eng.)	Sails on his last voyage never to return.
1848	Rebmann and Krapf (Ger.)	Mt. Kilima Njaro. Sighted Mt. Kenia.
1849–55	Richardson and Barth (Eng.-Ger)	Western Sudan and Sahara.
1850	Sir R. M'Clure (Irish)	Northwest Passage.
1852–4, 1861	Sir C. R. Markham (Eng.)	Explorations in Peru.
1856–59	Du Chaillu (French)	Basin of Ogowé River, W. Africa
1858	Sir R. Burton (Scot.)	Lake Tanganyika
"	Speke and Grant (Brit.)	Victoria Nyanza.
1860	Sir S. Baker (Eng.)	Explores Upper Nile. Discovers Albert Nyanza, 1864.
1862	M'Douall Stuart (Scot.)	Crossed Australia.
1862–63	W. G. Palgrave (Eng.)	Journeys in Central and Eastern Arabia.
1864–66	G. Rohlfs (Ger.)	Journey in W. Sudan by Ghadames, Murzuk, and Wadai to R. Niger.
1867–72	Richthofen (Ger.)	Extensive travel and exploration in China.
1868–71	G. Schweinfurth (Ger.)	Exploration of the Jur, Niam-Niam, and Monbuttu countries.
1869	G. Nachtigal (Ger.)	Explorations in Lake Chad region and Central Sudan States.
1870–1886	Prejevalsky (Rus.)	Journeys in Mongolia, Tibet, etc.
1871–75	Leigh Smith (Eng.)	Exploration of N. part of Spitzbergen. Vaigats Is.
1872	Payer and Weyprecht (Austrian)	Franz Josef Land.
1872–76	"Challenger" Expedition (Brit.)	Explores the depths of the oceans.
1872–76	Ernest Giles	Traverses Northwest Australia.
1873	Warburton (Irish)	Crosses Western Australia from East to West.
1874–75	Lieut. Cameron (Eng.)	Crosses Equatorial Africa.
1876	De Breeze (French)	Explorations in the Ogowé and Gabun region.
1876–90	H. M. Stanley (Eng.)	Congo Basin; Mt. Ruwenzori; Forests on the Aruwimi, etc.
1876	Sir Geo. Nares and A. H. Markham (Eng.)	Grant Land. Penetrated as far N. as 83° 20′ lat.
1878–79	Nordenskjöld (Swed.)	Northeast passage.
1878–89	Thomson (Scot.)	Journeys through Masai Land, British South Africa, Sokoto, Morocco, etc.
1878–85	Major Serpa Pinto (Port.)	Twice crosses Africa.
1878–92	Emin Pasha (Ger.)	Travels and Surveys in Equatorial Africa. Discovery of Semliki River, etc.
1879	Moustier and Zweifel (Swiss)	Sources of the Niger.
1881–85	Greely (U. S.)	Grinnell Land and NE. coast of Greenland.
1885	Wiesmann (Ger.)	Across Africa from West coast, Congo Basin.
"	Junker (Rus.-Ger.)	Welle-Mobangi, etc.
1886	Peary (U. S.)	North Greenland.
1887	Capt. Younghusband (Eng.)	Travels from Pekin to Kashmir.
1893–96	Nansen (Norw.)	Hviotenland, etc.; reached his "Farthest North" in lat. 86° 13′ 6″ N.
1897	Jackson (Scot.)	Surveys and explorations in Franz Josef Land.
1893–97	Sven Hedin (Swed.)	Explorations in North Central Asia.
1895–96	Pr. Henri d'Orléans	Travels in Tonkin and China.
1896	Donaldson Smith (Scot.)	Explores region of Lake Rudolf.
1896–98	Capt. Marchand	Travels from Upper Mobangi to Fashoda.
1897	Andrée (Swed.)	Attempt to cross over the North Pole in a balloon, with fatal results.
1897	D. Carnegie	Crosses Western Australia from S. to N.
1898–99	De Gerlache (Belgian)	"Belgica," first ship to winter within Antarctic circle.
1899	Major Gibbons	Explorations in Congo and Zambezi headwaters.
1900	Borchgrevink (Brit. Ex.)	Reached lat. 78° 50′ S. via Victoria Land.
"	Duke of Abruzzi (Ital.)	Reached lat. 86° 33′ N. via Franz Josef Land.
1900–02	Sven Hedin (Swed.)	Important Journey in Central Asia.

—*Bartholomew's Atlas.*

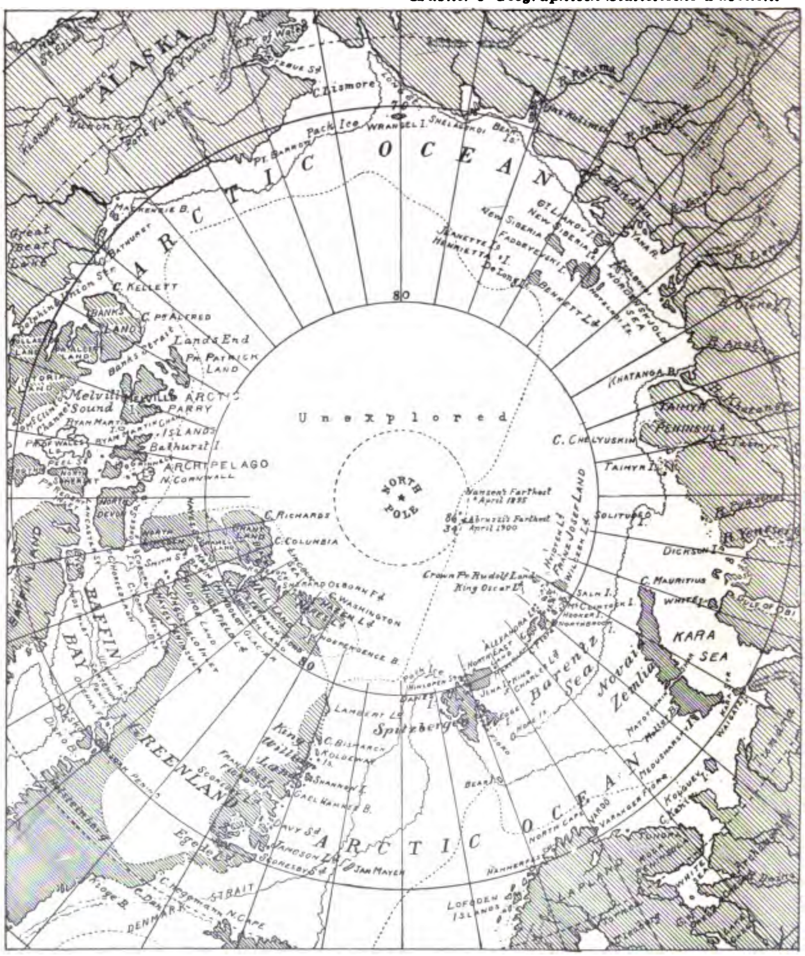


DISTRIBUTION OF LAND AND WATER OF THE EARTH'S SURFACE AND THE DIVISION OF LAND IN FIVE CONTINENTS.

TOTAL AREAS AND POPULATION OF THE POLAR REGIONS.

	Square Miles.	Square Kilometers.	Population. In Thousands.	Population. Per Square Mile.	Population. Per Square Kilo.
(1) Under no sovereignty	1,103,554	2,858,210	....	....	....
(2) Danish possessions on Greenland	34,015	88,100	12	0.3	0.1
(3) British possessions:					
Arctic Island in North America	502,354	1,301,100	1	0.00	0.00
South Georgia	1,573	4,075	....	....	....
(4) Russian possessions in the Arctic Ocean (New Siberian Islands)	14,895	38,580	....	....	....
	1,656,391	4,290,065	13	0.3	0.1

—*Hübner's Geographisch-Statistische Tabellen.*



MAP OF THE ARCTIC REGIONS. —*Bartholomew's Atlas.*

THE POLAR REGIONS.

National emulation, more particularly since the great success of Nansen, seems to have played the chief role in all the recent researches undertaken in the vicinity of the poles.

No fewer than three expeditions were organized in 1902 for the main purpose of reaching the North Pole. Otto Sverdrup, the Norwegian, with Nansen's old ship, the "Fram," started in through Smith Sound; Lieut. Robert E. Peary, of the United States navy, pursued a like course; while Mr. E. B. Baldwin, also an American, selected Franz Josef Land as his point of departure, although Prince Luigi, of Savoy, had only just vainly attempted it.

The expedition led by Capt. Sverdrup was incontestably the most successful, says Dr. Herman Haack in his Geographen Kalender. As early as 1898 his expedition was already under way. He spent the first winter north of Cape Sabine, where, by means of extended sledge journeys, he explored the fiords of Hayes Sound, in the following spring even advancing as far as the west coast of Ellesmereland. Finding the ice conditions no more favorable in 1899 than in the previous summer, he abandoned forthwith his former plan and fixed upon Jones Sound as the starting point for his investigations, in the hope of finding on the west coast of Ellesmereland a better and freer water course to the north than the narrow neck of Smith Sound can afford, which is so easily obstructed by the pack ice from the Pole. Sverdrup met with difficulties in Jones Sound also, for he could push no farther forward than Inglefeld had reached in 1852, and so he took up his second winter quarters at the point where the coast of Ellesmereland seemed to bend northward, under north latitude 76 deg. 29 min. and west longitude 84 deg. 24 min.

The sledge journeys of the fall of that year established the fact that Ellesmereland extended much farther westward than was supposed, and was separated from North Kent only by the Belcher Channel, a small arm of the sea. In the spring of 1900 Sverdrup continued the exploration of the west coast of Ellesmereland, where he discovered a deep fiord, while his assistant, Isachsen, examined a large body of land lying to the west of it. The "Fram" being free from ice in August, the passage through Jones Sound was continued, but the ship was soon fast again in the Belcher Channel near the westernmost point of Ellesmereland, and Sverdrup established his third winter quarters under latitude 76 deg. 48 min. and longitude 89 deg. The fall of 1900 and the spring of 1901 were devoted to sledge journeys.

Sverdrup himself continued his exploration of Ellesmereland, examining anew and more thoroughly the fiord which he discovered the year before, after which he turned northward and succeeded in reaching the most westerly point occupied by him in the spring of 1899, to which he had then proceeded from Smith Sound.

Isachsen proceeded westward and discovered north of North Cornwall two larger islands, exploring their southern coasts till they turned toward the north. Under latitude 79 deg. 30 min. and longitude 106 deg., he reached his farthest western limit, from which point neither to the west nor to the north was any land visible, and from the character of the floating ice it was not probable that any land existed in either direction. In July of that year the north coast of North Devon was explored in boats.

All attempts to get the "Fram" out of the ice having failed, Sverdrup was compelled to pass a fourth winter in 1901-2 in this region, during which other extended sledge journeys were undertaken. Following the west coast of Ellesmereland, Sverdrup attempted to reach 80 deg. 16 min. N., 85 deg. 33 min. W., the farthest point attained by Lieut. Aldrich, of the English Polar Expedition of 1875-76, on the west coast of Grinnell Land, coming down from the north. He was not successful, however, though he penetrated as far north as 80 deg. 37 min., which was but a short distance from the goal. Sledge journeys undertaken by other participants in the expedition resulted in the exploration of the west coast of North Devon. In the beginning of August, 1902, when the "Fram" was again free from ice, Sverdrup started immediately upon his homeward way, reaching Stavanger on the 19th of September. The chief result of this expedition was the discovery of large land areas west of Ellesmereland, and since the discovery of Franz Josef Land no such extension of our knowl-

edge of these regions has been signalized.

Lieut. Robert N. Peary, U. S. N., conceived a plan of reaching the North Pole by sledge journeys, accompanied by no one but Esquimaux and his black servant Henson. For this purpose it became necessary to establish, well to the south, a point of departure that could be reached every year by a ship, which could supply fresh provisions and new outfittings, that were to be pushed toward the north and deposited in caches along the coast. The weak point of the scheme lay in the fact that the advance to the farthest points already reached required so much time for so small a sledge crew that further penetration into the unknown must be undertaken at an advanced season of the year, when the stability of the ice made such a movement questionable. The winter of 1898-99 Peary passed at Etah, on the eastern shore of Smith Sound, in order to interest the aborigines in his plan, buy dogs, and perfect other preparations. After his ship, the "Windward," reached him with fresh supplies in the fall of 1899, he was transported to Cape Sabine, which he had fixed upon as the starting point and base of the expedition. Here he passed the winter of 1899-1900. In the spring of 1900 he undertook a sledge journey straight across Ellesmereland, and in the fall of that year established a line of depots toward the north. In the spring of 1901 he made the first energetic move toward the Pole, which led him from Grant Land in the direction of Greenland. He passed the most northern point, 83 deg. 24 min., reached by Lockwood in the Greely expedition of 1882, and fixed, under latitude 83 deg. 39 min., the northern extremity of Greenland. He followed the coast toward the east until it began to bend decidedly to the southeast in the direction of Independence Bay, thus establishing the insular nature of Greenland.

On his return he made a dash for the north and reached 83 deg. 50 min., the highest point thus far attained on the American side of the polar archipelago. During the spring of 1902, Peary even exceeded this. Starting from Cape Hekla, the northernmost point of Grant Land, he proceeded over the ice as far as 84 deg. 17 min., while Capt. Markham, in 1876, succeeded only in reaching 83 deg. 20 min. from this side. From the European side, however, Capt. Cagni, of the Italian expedition, starting from Franz Josef Land, attained the advanced position of 86 deg. 34 min.

Peary was obliged to make his dash in April, and, as was the case with Markham, he found the ice in a very unsatisfactory condition; the immense hummocks of compressed drift-ice increased the difficulties of travel for both dogs and men. There were no traces, however, of the unchangeable paleocrystic ice mentioned by Markham, for on the return Peary met with numerous open places and channels which caused serious delays. No land was visible to the north of either Greenland or Grant Land. In spite of the unsuccessful termination of his expedition, Peary is still convinced that the best point of departure is from the American side of the archipelago, and, moreover, that, with an early start from Grant Land, the Pole may be reached by sledge. Though Sverdrup and Peary added to our knowledge of the Polar regions, the third expedition fitted out by Mr. Ziegler, an American, and under the direction of Mr. Baldwin, who started from Franz Josef Land for the Pole, was closed without definite results. Several small islands were discovered; the hut in which Nansen and Johansen lived in 1895-6 was again found; some scientific events were noted; meteorological sketches and photographs of the Northern Lights were made, and yet the finality of the expedition was a fiasco. No earnest attempt to reach the Pole was made. Serious friction between Baldwin and Fridtjof, the sailing master of the expedition, is responsible for the unsuccessful termination.

Among the most important of the Polar expeditions is that led by Baron Toll, a Russian, for the discovery and exploration of the island either existing or supposed to exist to the north of the New Siberian Islands. Having twice before, in 1886 and 1894, visited the northernmost of these islands, Toll left Europe again in 1900 in the steamship "Sarja" upon a similar quest. Upon entering the Sea of Kara, he did not pick up the ship which was bringing him coal, and since both the condition of the ice and the open sea were favorable to his designs, he preferred not to wait for it. Cape Tscheljuskin, the extreme northern point of Asia, and the intended termination of the first summer's journey, was not reached, but the condition of the ice

compelled him to put into Colin-Archer haven, at the entrance to the Taimyr Straits, on September 26, where he passed the winter.

Failing in two attempts to gain the mouth of the Jenissei by crossing the land, Lieutenant Kolomeizoff finally reached it by following the coast. During the spring of 1901, the extent of Taimyr Bay was carefully explored upon sleds, and through the discovery of the hut in which Lapten spent the winter of 1840-1, as well as by reaching the most northern station of the Middendorf expedition of 1843, the mouth of the Taimyr River was definitely fixed. The "Sarja" could not proceed till August 25. Cape Tscheljuskin was safely rounded and the course set for the location where, according to Toll's observation in 1886, the distant Polarland, seen as early as 1811 by Sannikow, to the north of Kotelny, ought to be. This point was passed without sighting the supposed land, and a few miles before reaching Cape Emma, the southernmost point on Bennett Island, discovered by the "Jeannette" expedition, the ice became so packed that further progress northward was impossible. On the return voyage the ship cruised again in the vicinity of the supposed Sannikow land, but without sighting it. On September 24, 1901, the "Sarja" froze in at the island of Kotelny, in Nerpitscha Bay, where the expedition passed the winter. Whether or not Sannikow and Toll were deceived as to what they saw cannot yet be determined. It is quite possible that they may have miscalculated the distance and that the island may lie farther north in a section not touched even by Nansen's drift in the "Fram" during the long winter night of his journey in 1893-4. Being unable to get coal from the Lena River, the "Sarja" became unfit for long journeys; accordingly Toll resolved upon sledge journeys to the north, similar to those undertaken from the "Fram" by Nansen. The geologist, Birula, began such a journey May 11, intending to explore the largest of the New Siberian Islands. On June 5 Toll followed him, accompanied by the astronomer Seeberg and two Jakuts, but touched only at the northernmost point, Cape Wyssoki, which he left on July 13, crossing the ice for Bennett Island. Toll left Lieut. F. Mattheissen in charge of the "Sarja," but August 21 arrived before any earnest effort could be made to proceed to New Siberia and Bennett Land to bring back the sledge parties. About Kotelny and Faddejew the ice was so thick that these islands could be passed neither to the north nor the south, and since the open season was fast drawing to a close, Mattheissen brought the "Sarja" back to the Lena, where he anchored in the bay of Tiksi September 8. Being too deep of draft to steam up the river, the "Sarja" was abandoned, and the crew, together with the scientific collection and instruments, were transferred to Jakutsk on the small steamer "Lena."

It was expected that Toll and Birula would return to the mainland at the beginning of winter, but Birula returned in 1903, in good health, without having seen Toll. Perhaps the condition of the ice between Bennett Land and New Siberia prevented Toll's return, and it was held that he would attempt it again in the spring of 1903.

THE GREAT [LAURENTIAN] LAKES.

Lakes.	Length, Miles.	Breadth, Miles.	Area, Sq. Miles.	Height above Sea, Feet.
Superior	390	160	31,420	602¾
Huron (with Georgian Bay)	400	160	24,000	576¾
St. Clair	25	25	360	570¾
Erie	250	60	10,000	566¾
Ontario	190	52	7,330	240
Michigan	345	58	25,590	578¾

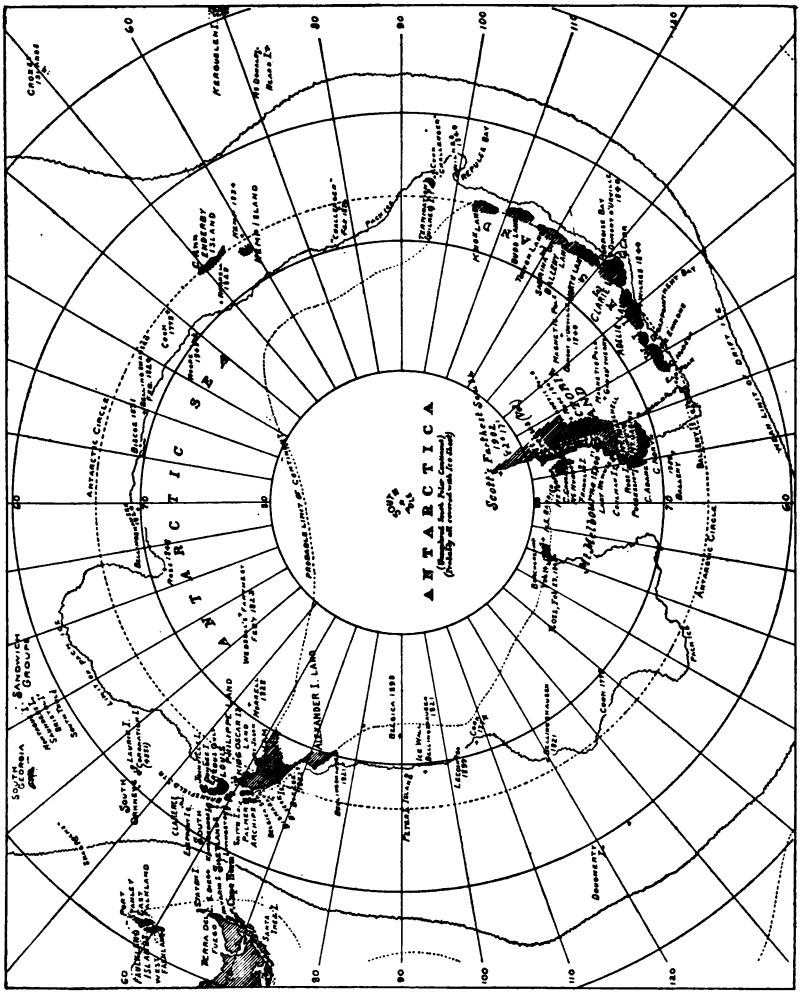
Lake Michigan is wholly within the United States and is connected with Lake Huron by the Strait of Mackinaw.

—*Statistical Year Book of Canada.*

ANTARCTIC EXPLORATIONS.

Though the quest of the North Pole has monopolized the world's attention for more than a century, it has of late not been entirely without a rival. The British expedition broke the farthest-south record by reaching the latitude of 82 deg. 17 min. Mr. Borchgrevink previously held the record at 78 deg. 51 min.

THE BRITISH EXPEDITION sailed from London in July, 1901, on the Discovery, under command of Capt. Scott, R. N. Fearful lest the currents might destroy the expedition, a rescuing party was dispatched in 1902 under Lieut. William Colbeck, who took part in the Borchgrevink South Polar expedition. The rescuers on the Morn-



MAP OF THE ANTARCTIC REGIONS.

—*Bartholomew's Atlas* (with additions.)

ing left Wellington, December 6, 1902, and returned to the same place March 25, 1903, bringing reports of the successful work of the main expedition. The Discovery reached Cape Adare, the northernmost point of Victoria Land, January 9, 1902, and followed the coast south; from Mt. Erebus the ship skirted the wall of ice, discovered by Ross, as far as longitude 165 deg. E., where it turned more to the north. Behind the ice wall reared the highlands covered with glaciers which Ross had sighted.

Under 67 deg. N. and 152 deg. 30 min. E. the ship reached its farthest point, whence it returned to Victoria Land to go into winter quarters in MacMurdo Bay, near the volcano Mt. Erebus, in longitude 174 deg. E.

Sledge journeys began in September, 1902. The one led by Captain Scott marched for three months, attaining a point under 82 deg. 17 min., which surpassed Borchgrevink's 78 deg. 50 min. by nearly 3½ deg. A second sledge party, commanded by Lieutenant Armitage, turned westward of Erebus, and during a march of fifty-two days reached an elevation of 9,000 feet. This is the more noteworthy since all the dogs died, supposedly from spoiled provisions. The Morning found the Discovery still in winter quarters, and when the rescuers departed the Discovery seemed still fast in the ice.

Late in 1903 the Morning and the whaler Terra Nova were refitted and started on a second expedition to the relief of the Discovery. The latter was found on February 14 and the three vessels returned to Lyttleton, New Zealand, on April 1, 1904. Among the chief results of the expedition was the discovery that Mount Erebus and Mount Terror are on a small island, and that there is a large land mass lying west and southwest of the ice barrier, with ice plateaus 9,000 feet in height and peaks which reach to 14,000. It was discovered that the ice barrier is afloat, though fed from land, and that high land lies to the southeast of the hitherto unknown extremity of the barrier.

THE GERMAN EXPEDITION,

which entered the ice-pack south of the Indian Ocean on February 13, 1902, left it on April 9, 1903, and returned from a voyage highly fruitful of scientific results, although not comparable with the voyage of the Discovery in sensational experiences. Incidentally it has swept away the Termination Land of Wilkes, passed the winter in the close pack, carried out numerous and important sledge journeys, discovered new land (called Kaiser Wilhelm II. Coast), and actually reached land in the solitary peak called the Gaussberg. Balloons were used successfully during the expedition. The farthest south was 66 deg. 2 min., and the ship was frozen for many months in ice 30 feet thick.

THE SWEDISH EXPEDITION,

under Captain Otto Nordenskjöld, left Europe in October, 1901, and entered the Antarctic regions in February, 1902. The ship returned from the Falkland Islands to Graham's Land in March, 1902, went south again in the southern summer of 1902-1903. With the assistance of the Swedish government the Norwegian steamer Frithjof was dispatched for the relief of the Antarctic, whose commander, by the way, is Captain Larsen, well known for his Antarctic voyage in the Jason. To the Republic of Argentine, which sent the gunboat Uraguay, belongs the honor of having rescued the Swedish expedition, which was found at Snow Hill on Louis Philippe Land in desperate straits, their vessel having been crushed by the ice and sunk on February. 12, 1903.

THE SCOTTISH EXPEDITION,

on the Scotia, under the command of Mr. W. S. Bruse (formerly of the Jackson-Harmsworth expedition), set sail on November 3, 1902, for what is known as the Weddell quadrant of the Antarctic regions, with the intention of following in the wake of Captain Jas. Weddell, who reached a high southern latitude in open sea. This route was advisedly selected, as the Scottish expedition is devoting its attention to oceanographical work. Captain Robertson, the well-known whaling skipper, commanded the Scotia. Contrary to expectation, the Scotia wintered in the ice, and no further news of her has yet been received.

THE FRENCH EXPEDITION,

under the command of Dr. Charcot, sailed from Havre in August, 1903, to explore Alexander Land. The original plan of the expedition was to explore Nova Zembla, but just then the Swedish expedition was causing a great deal of anxiety, and it was decided to direct the expedition toward the South Pole in search of Nordenskjöld. The rescue of the Swedish expedition then left Dr. Charcot free to make explorations in Antarctic regions.

AREA AND POPULATION OF THE PRINCIPAL COUNTRIES COMMERCE WITH

Revised and Corrected by the Bureau of

Countries.	Area and Population.		
	Area.	Population.	Population per Square Mile.
	Sq. Miles.		
Argentina	1,135,840	4,794,000	4.22
Australasia: Commonwealth	2,972,573	3,772,000	1.27
New Zealand	104,751	788,000	7.52
Austria-Hungary	241,333	45,405,000	188.14
Austria	[2a] 115,903	[2a] 26,151,000	225.63
Hungary	[2a] 125,430	[2a] 19,254,000	153.51
Belgium	11,373	6,694,000	588.59
Bolivia	703,604	1,816,000	2.58
Brazil	3,219,000	14,334,000	4.45
British colonies, n. e. s.	951,333	14,434,000	15.17
Bulgaria	38,080	3,744,000	98.33
Canada	3,048,710	5,457,000	1.79
Central America: Costa Rica	23,000	313,000	13.61
Guatemala	46,774	1,647,000	35.21
Honduras	46,250	775,000	16.76
Nicaragua	49,200	[19] 500,000	10.16
San Salvador	7,225	1,007,000	139.38
Chile	279,901	3,051,000	10.90
China	1,532,420	407,253,000	265.76
Colombia	504,773	[9] 4,000,000	7.92
Cuba	43,000	1,573,000	36.58
Denmark	15,360	2,465,000	160.48
Ecuador	116,000	1,204,000	10.38
Egypt	383,900	9,734,000	25.36
Finland	144,255	2,744,000	19.02
France	207,054	38,962,000	188.17
Algeria	184,474	4,739,000	25.69
Tunis	51,000	1,900,000	37.25
French colonies, n. e. s	3,375,602	26,427,000	7.83
French East Indies [6]	461,196	18,346,000	39.78
German Empire	208,830	58,549,000	280.36
German colonies	1,025,829	13,543,000	13.20
Greece	25,014	2,434,000	97.31
Haiti	10,204	1,294,000	126.81
India, British [7]	1,766,642	294,361,000	166.62
Italy	110,646	32,475,000	293.50
Japan	147,655	45,862,000	310.60
Formosa	13,458	2,706,000	201.07
Korea	84,400	[9] 12,000,000	142.18
Mexico	767,060	13,545,000	17.65
Netherlands	12,563	5,347,000	425.61
Dutch East Indies	736,400	35,736,000	48.53
Norway	124,130	2,263,000	18.23
Paraguay	97,722	636,000	6.51
Persia	628,000	[9] 9,500,000	15.13
Peru	713,859	4,610,000	6.46
Portugal	36,038	5,429,000	150.65
Roumania	50,700	5,913,000	116.63
Russia	8,660,395	141,000,000	16.28
Santo Domingo	18,045	610,000	33.80
Servia	18,630	2,536,000	136.12
Siam	236,000	5,000,000	21.19
Spain	194,783	18,618,000	95.58
Sweden	172,876	5,199,000	30.07
Switzerland	15,976	3,356,000	210.07
Turkey	1,115,046	24,932,000	22.36
United Kingdom	121,371	41,961,000	345.73
United States	[8a] 3,025,600	80,372,000	26.56
Philippine Islands	115,000	7,590,000	66.00
Uruguay	72,210	959,000	13.28
Venezuela	593,940	2,445,000	4.12
Total	41,414,336	1,508,659,000	....

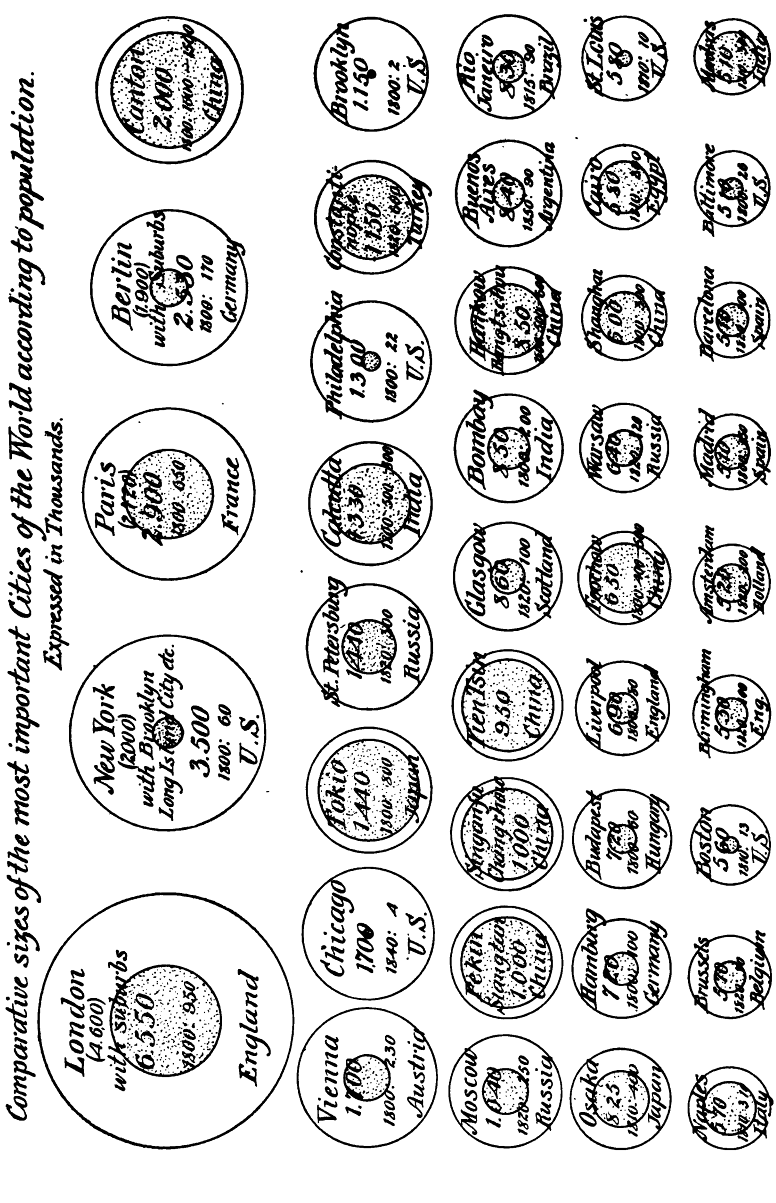
[1] Exclusive of intercolonial commerce, but including gold and silver. [2] Including gold [5] French Africa. [6] Includes French possessions in India and French Indo-China, viz., the feudatory States. [8] Included under Sweden. [8a] Exclusive of Alaska and Hawaii.

OF THE WORLD, THEIR TOTAL FOREIGN COMMERCE, AND THE UNITED STATES.

Statistics, Department of Commerce and Labor.

Foreign Commerce.				Commerce with the United States.	
Year.	Imports.	Exports.	Excess of Exports (+) or Imports (−).	Exports from United States to.	Imports into United States from.
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1902	99,433,000	173,205,000	+ 73,772,000	9,808,529	10,396,873
1902	[1] 203,644,000	[1] 213,713,000	+ 10,069,000	28,101,784	[2] 13,845,001
1902	[2] 55,121,000	[2] 66,403,000	+ 11,282,000		
1902	349,228,000	388,460,000	+ 39,232,000	6,672,580	10,093,346
....	....	....	....	....	....
1902	459,472,000	371,620,000	− 87,852,000	43,515,112	17,912,084
1902	5,587,000	11,076,000	+ 5,489,000	76,926	1,731
1902	113,288,000	177,323,000	+ 64,035,000	11,155,565	71,583,086
1902	475,370,000	280,744,000	− 194,626,000	57,886,757	22,875,024
1902	13,751,000	20,011,000	+ 6,260,000	....	....
[3] 1903	224,814,000	196,161,000	− 28,653,000	123,472,416	54,660,410
1902	4,415,000	5,661,000	+ 1,246,000	1,697,043	3,291,545
1900	3,018,000	7,134,000	+ 4,116,000	1,128,418	2,190,145
1902	1,672,000	2,357,000	+ 685,000	969,963	1,136,220
1901	2,185,000	3,243,000	+ 1,058,000	1,364,518	2,199,313
1902	2,624,000	3,926,000	+ 1,302,000	868,329	583,459
1902	48,336,000	67,846,000	+ 19,510,000	3,753,222	7,155,839
1902	198,364,000	134,720,000	− 63,644,000	22,698,282	26,182,113
1898	10,695,000	18,487,000	+ 7,792,000	2,923,404	3,140,043
[3] 1903	58,826,000	77,849,000	+ 19,023,000	21,769,572	62,341,942
1902	116,726,000	85,730,000	− 30,996,000	14,812,900	68,494
1902	7,029,000	8,811,000	+ 1,782,000	1,347,850	1,823,166
1902	73,229,000	87,081,000	+ 13,852,000	667,577	10,854,628
1902	45,191,000	39,117,000	− 6,074,000	([4])	([4])
1902	848,026,000	820,671,000	− 27,355,000	70,497,327	87,895,253
1902	64,228,000	60,804,000	− 3,424,000	[5] 386,758	[5] 461,102
1901	12,483,000	7,551,000	− 4,932,000		
1901–2	46,808,000	35,806,000	− 11,002,000	2,785,418	1,088,493
1902	41,964,000	40,677,000	− 1,287,000	62,361	3,873
1902	1,340,178,000	1,113,313,000	− 226,865,000	174,264,495	111,999,904
1901	8,969,000	4,497,000	− 4,472,000	30,949	11,702
1902	26,034,000	15,466,000	− 10,568,000	369,919	1,229,144
1901	5,500,000	12,760,000	+ 7,260,000	1,956,343	1,127,641
1902–3	255,614,000	408,396,000	+ 152,782,000	4,866,683	51,831,665
1902	342,718,000	284,177,000	− 58,541,000	33,135,512	33,612,864
1902	135,322,000	127,326,000	− 7,996,000	21,622,603	40,597,582
1902	5,030,000	6,881,000	+ 1,851,000		
1902	6,744,000	4,142,000	− 2,602,000	257,130	....
[3] 1903	74,690,000	88,200,000	+ 13,510,000	42,227,786	[2] 61,802,902
1902	867,308,000	732,975,000	− 134,333,000	74,576,164	20,899,588
1901	86,894,000	98,724,000	+ 11,830,000	2,210,963	15,343,948
1902	77,779,000	45,687,000	− 32,092,000	([8])	([8])
1902	2,270,000	3,787,000	+ 1,517,000	14,815	3,890
1902	23,703,000	13,243,000	− 10,460,000	....	....
1902	21,062,000	17,938,000	− 3,124,000	2,573,289	2,826,493
1902	60,044,000	30,710,000	− 29,334,000	2,915,897	3,229,813
1902	54,686,000	72,340,000	+ 18,654,000	138,635	65
1901	305,614,000	392,215,000	+ 86,601,000	7,518,177	7,262,757
1901	2,987,000	5,224,000	+ 2,237,000	1,700,371	3,361,319
1902	8,650,000	13,920,000	+ 5,270,000	....	33,149
1902	15,782,000	21,103,000	+ 5,321,000	....	....
1902	175,487,000	161,297,000	− 14,190,000	15,976,788	8,787,621
1902	134,605,000	105,154,000	− 29,451,000	9,530,137	4,193,307
1902	217,803,000	168,741,000	− 49,062,000	203,357	19,864,767
1898–99	117,134,000	59,072,000	− 58,062,000	354,457	2,359,830
1902	2,571,416,000	1,379,283,000	− 1,192,133,000	523,773,397	180,249,114
[3] 1903	1,025,719,000	1,392,231,000	+ 366,512,000	....	....
[3] 1903	32,972,000	33,122,000	+ 150,000	4,038,909	11,372,584
1902	24,565,000	33,656,000	+ 9,091,000	1,549,812	2,830,069
1898	8,560,000	14,900,000	+ 6,340,000	2,736,726	6,609,919
....	11,621,366,000	10,266,667,000	− 1,354,699,000	1,356,965,925	1,003,224,820

and silver. [2a] Not included in total. [3] Year ending June 30. [4] Included under Russia. Cochin China, Tonkin, Annam, Cambodia, and Laos. [7] Including area and population of [9] Estimated.


Comparative sizes of the most important Cities of the World according to population.
Expressed in Thousands.
London
England
New York
U.S.
Paris
France
Berlin
Germany
Canton
China
Vienna
Austria
Chicago
U.S.
Tokio
Japan
St. Petersburg
Russia
Calcutta
India
Philadelphia
U.S.
Constantinople
Turkey
Brooklyn
U.S.
Moscow
Russia
Peking
China
Tien Tsin
China
Glasgow
Scotland
Bombay
India
Buenos Ayres
Argentina
Rio Janeiro
Brazil
Osaka
Japan
Hamburg
Germany
Budapest
Hungary
Liverpool
England
Warsaw
Russia
Shanghai
China
Cairo
Egypt
St. Louis
U.S.
Naples
Italy
Brussels
Belgium
Boston
U.S.
Birmingham
Eng.
Amsterdam
Holland
Madrid
Spain
Barcelona
Spain
Baltimore
U.S.
Madras
India

CHAPTER II.

SHIPPING AND YACHTS.

SUMMARY OF SHIPPING.

The growth of our merchant marine is slow, and is in no sense commensurate with our phenomenal advancement in manufactures and commerce. At the same time, it is a fact worthy of note that the documented tonnage of the United States on June 30, 1903, for the first time in our history exceeded 6,000,000 gross tons register, comprising 24,425 vessels of 6,087,345 gross tons. These figures do not include 1,828 yachts of 74,990 gross tons. The total shipping of the United Kingdom for 1902 was 20,258 vessels, of 15,357,052 gross tons (vessels of British colonies number 15,533 of 512,268 net tons). On January 1, 1902, the total shipping of the German Empire was 6,024 vessels of 3,503,551 gross tons. The shipping of the United Kingdom and Germany is largely employed in developing foreign trade. The shipping of the United States is almost wholly a part of our domestic transportation system. On June 30, 1903, 5,141,037 gross tons were engaged in transportation and coastwise trade, 879,264 gross tons were devoted to foreign trade, and 67,044 to fisheries. The distribution of our tonnage on June 30, 1903, was: Atlantic Ocean, 3,157,373 gross tons; Pacific Ocean, 812.179 gross tons; the Great Lakes, 1,902,698 gross tons; Mississippi system, 215,095 gross tons. Our shipping on the Pacific has increased more rapidly than on the Atlantic. In regard to motive power, 3,408,088 gross tons were propelled by steam, and 1,965,924 gross tons were sailing vessels, and 713.333 gross tons of canal-boats and barges were variously propelled. As regards the materials of construction, 2,440,247 gross tons were of iron and steel construction, and 3,647,098 gross tons were of wood. The following table shows the geographical distribution, motive power, and material of construction of American shipping June 30, 1903.

American Shipping.	Number.	Gross Tonnage.
GEOGRAPHICAL DISTRIBUTION.		
Atlantic and Gulf coasts	17,218	3,149,711
Porto Rico	59	7,662
Pacific coast	2,575	775,859
Hawaiian Islands	69	36,320
Northern lakes	3,110	1,902,698
Western rivers	1,394	215,095
Total	24,425	6,087,345
POWER AND MATERIAL.		
Sail:		
Wood	16,187	2,391,017
Iron and steel	184	288,240
Total	16,371	2,679,257
Steam:		
Wood	6,675	1,256,081
Iron and steel	1,379	2,152,007
Total	8,054	3,418,088
Canal boats	695	78,406
Barges	2,840	634,927
Total	3,535	713,333
CONSTRUCTION DURING THE YEAR 1903.		
Geographical distribution.		
Altantic and Gulf coasts	847	244,860
Pacific coast	191	43,336
Northern lakes	123	136,844
Western rivers	150	11,112
Total	1,311	436,152
Power and material.		
Sail:		
Wood	466	77,795
Steel	4	12,184
Steam:		
Wood	451	31,674
Iron and steel	100	240,107
Canal boats	19	2,215
Barges:		
Wood	267	66,249
Steel	4	5,928
Total	1,311	436,152

During the years 1902 and 1903, nearly 100,000 tons of large ocean-going steamers have been added to our registered fleet.

The subject of the losses of vessels from various causes is a most important one. During the year ending June 30, 1903, 487 vessels of 107,084 gross tons were reported. The number and rig of vessels lost is shown by the annexed table:

nearby countries. The excellent lighthouse system of the American coast and care in navigation have, however, overcome liability to accident from the nature of our trade along the coasts. Collision differs totally from stranding in that, for its prevention, one must look to the navigating officers. The figures show that superior care and intelligence are possessed by the navigating officers of American steamers.

Rig.	Stranded.	Collision.	Fire.	Foundered.	Abandoned.	Total.
Steam	21	8	49	28	....	106
Sail	153	25	61	107	13	359
Unrigged	7	3	2	10	....	22
Total	181	36	112	145	13	487

The very heavy percentage of loss of steamers by fire discloses unsatisfactory attention to duty in the hold or insufficient fire apparatus, or both. The table given includes lost American vessels of all sizes on the rivers and lakes of the country, as well as salt water. For comparison of the relative losses of the merchant shipping of the United States and foreign nations, the most complete figures are those of the "Bureau Veritas." They cover only sea-going steamers of over 100 gross tons and sea-going sail vessels of over 50 net tons. The proportion of foreign vessels on the ocean is so great and of American vessels so small that the figures do not clearly disclose the relative security of navigation under various flags and laws. Figures show that American sea-going vessels from 1896 to 1903 have been less liable to accident but more liable to total loss than foreign steamers, while American sea-going sail vessels have been more liable both to accident and loss than foreign sea-going sail vessels. The losses of both steamers and sail vessels of all nations are due, of course, more to stranding than to any other cause, as it accounts for 47 per cent. of the losses of American sea-going steamers and 53 per cent. of the losses of American sea-going sail vessels. The losses of foreign steamers are 44 per cent., and the losses of foreign sail vessels 46 per cent. There is a special reason why American vessels are more liable to stranding than the vessels of other nations which conduct the world's deep-sea trade. American vessels are seldom found in midocean on long voyages. Their course is usually along our own coasts in the domestic trade, or in trade with

The third cause of loss and accident in the order followed by the "Bureau Veritas" is fire. The element of direct human responsibility in the case of fire is considerably greater than in cases of collision, where fog and the fault of the second party to the collision may produce disaster, and is much greater than in cases of stranding, where fog, defective charts, and an inadequately lighted coast add to the perils which stress of weather always creates. Afloat or ashore fire seems usually to be a peril to life and property, to be guarded against only by a higher degree of men's watchfulness or by better extinguishing appliances. Each vessel is separated usually by the water from every other vessel as buildings ashore are not separated, so that extra precautions should produce better results with ships than with buildings. The American steam fleet contains a considerable proportion of wooden hulls, while foreign steamers are usually steel. Still it is not pleasant to notice that while the loss of 18 per cent. of lost American steamers may be charged to fire, the loss of only 4 per cent. of lost foreign steamers is charged to this cause; that while 8 per cent. of damaged American steamers suffered from fire, only 5 per cent. of foreign vessels came from this cause; that 4 per cent. of lost American sail vessels were burned and only 2 per cent. of lost foreign sail vessels were burned. The only relieving feature of these particular figures is that the proportion of accidents from fire to American sail vessels—3 per cent. of the total—was the same as to foreign vessels. The situation disclosed may be corrected. Whether that correction should come from the under-

writers or from the Government in its legislative or executive branch is not now considered.

Collision to a great extent, and fire to a greater extent, cause loss or accident to vessels mainly through lack of skill and vigilance of the officers and crew. Except where caused by unusual storms or waves vessels founder, on the other hand, on account of structural weakness of the hull. This weakness may be inherent and the fault of the builder, or it may be due to age and inadequate repair, the fault of the owner. In rare cases a new vessel, splendidly built, may yield to the tempest. The separation of causes of loss by the "Bureau Veritas" into foundered, abandoned, and missing, while proper enough from the point of view of the statistician, is not wholly satisfactory to those required to deal with facts from the point of view of possible remedy. The three classes, foundered, abandoned, and missing, really constitute one class for remedial purposes. That class consists of vessels which, on account of defects of the hull, are lost at sea. Most of them founder. Some of them are abandoned by their crews and the ship does not actually go down before their eyes. All of these ultimately go down except the proportion kept afloat by their cargoes, such as lumber-laden schooners. This small proportion constitutes the class known as "derelicts." Leaks (defects in a vessel's bottom) cause about 2 per cent. of the accidents to American steamers and to foreign steamers. Leaks, again, cause 20 per cent. of the accidents to American sail vessels, and only 15 per cent. of the accidents to foreign sail vessels.

Stress of weather or storms accounted for 10 per cent of the accidents to American steamers, 13 per cent. of accidents to foreign steamers, 30 per cent. of accidents to American sail vessels, and 35 per cent. of accidents to foreign sail vessels. Doubtless the excellent system of weather reports and storm warning along the American coasts helps to produce this favorable showing for American vessels. The principal cause of accidents to American steamers lies in the engines and boilers to which 29 per cent. of our steamer accidents are charged, compared with 24 per cent. for foreign steamers. Collision (31 per cent.) is the principal cause of British steamer accidents; stranding (31 per cent.) of German accidents. Accidents to engines and boilers may be due to defective original construction, to inadequate repairs, or to faults of the men in charge of them. Generally speaking, American machinery holds a high place in the world's esteem, and while positive evidence is not at hand, it still seems probable that American marine engines and boilers are equal to those of foreign make. If that be so then the large proportion of accidents from engines and boilers must proceed from one or both of the other two causes mentioned. The returns of the number of men including masters required to man the documented fleet of merchant vessels and yachts of the United States report crews aggregating 135,828 men, 88,249 men being engaged on steamers, while the crews of sailing vessels number 45,030 men, and unrigged boats require 2,549 men to man them. These figures are only for the crews reported.

Returns for 1903 show that 3,086 American steam vessels, including yachts, aggregating 2,994.866 gross tons, are propelled by engines aggregating 2,369,202 indicated horsepower. The figures indicate an annual consumption of about 10,000,000 long tons of coal for fuel on these steamers, and the employment on board of about 20,000 men as firemen and trimmers. The total number of steam vessels (including motor launches) on June 30, 1903, was 8,801 of 3,459,644 gross tons, so that the figures stated cover 86 per cent. of our steam tonnage, including yachts. In the navy 207 steam vessels of 206,953 tons (displacement) are propelled by engines of 624,745 indicated horse-power.—Condensed from the Report of the U. S. Commissioner of Navigation.

Flag Day.—Flag Day is June 14. "Old Glory" was 127 years old on June 14, 1904.

NATIONAL SWISS RAILWAYS.

Four of the chief railway lines in Switzerland—the Central Suisse, the Nord Est, the Union Suisse, and the Jura-Simplon—have been nationalized. There only remains the St. Gothard Company. The existing concession will be renounced 1905, and the purchase price fixed on the basis of the average returns of the 10 years preceding 1894-1904.

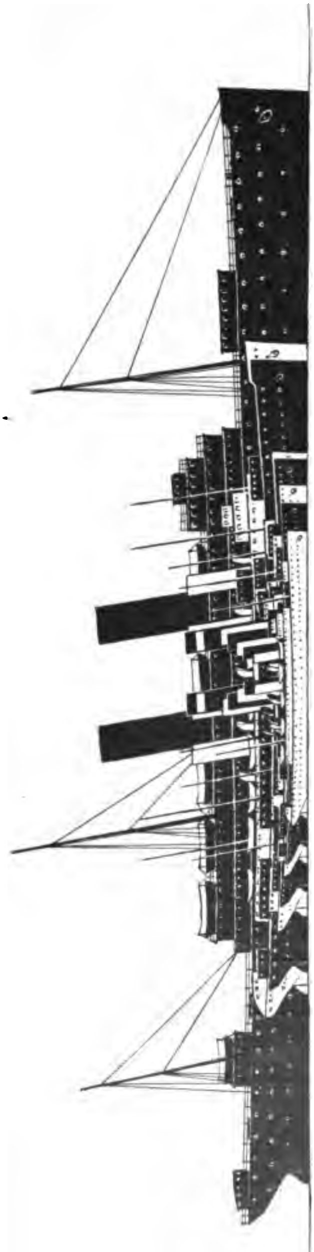
STATEMENT OF NUMBER AND NET AND GROSS TONNAGE OF STEAM AND SAILING VESSELS OF OVER 100 TONS, OF THE SEVERAL COUNTRIES OF THE WORLD, AS RECORDED IN LLOYD'S REGISTER FOR 1903-4.

Flag.	Steam.			Sail.		Total.	
	Number.	Net Tons.	Gross Tons.	Number.	Net Tons.	Number.	Tonnage.
British:							
United Kingdom......	7,530	8,233,721	13,410,894	1,622	1,478,677	9,152	14,889,571
Colonies.............	1,023	466,732	782,688	959	334,115	1,982	1,116,803
Total.............	8,553	8,700,453	14,193,582	2,581	1,812,792	11,134	16,006,374
American (United States):							
Sea..................	862	810,003	1,220,995	2,119	1,259,986	2,981	2,480,981
Lake.................	349	756,470	1,001,072	56	129,903	405	1,130,975
Total.............	1,211	1,566,473	2,222,067	2,175	1,389,889	3,386	3,611,956
Argentine.............	119	44,678	70,862	99	24,918	218	95,780
Austro-Hungarian.......	267	348,461	557,745	29	20,952	296	578,697
Belgian...............	112	103,459	156,559	2	488	114	157,047
Brazilian.............	228	84,110	132,107	90	22,979	318	155,086
Chilean...............	49	42,164	67,186	59	36,572	108	103,758
Chinese...............	45	38,807	60,491	.....	....	45	60,491
Cuban.................	41	24,703	38,550	12	2,324	53	40,874
Danish................	385	283,490	483,968	414	97,279	799	581,247
Dutch.................	360	387,800	613,219	98	45,626	458	658,845
French................	717	584,180	1,153,761	638	468,255	1,355	1,622,016
German................	1,425	1,720,106	2,794,311	473	488,936	1,898	3,283,247
Greek.................	199	205,996	325,895	192	52,304	391	378,199
Italian...............	365	448,704	704,109	861	476,226	1,226	1,180,335
Japanese..............	544	366,232	585,542	1,042	141,276	1,586	726,818
Mexican...............	32	9,070	15,210	16	3,678	48	18,888
Norwegian.............	962	570,869	935,229	1,256	718,511	2,218	1,653,740
Philippine Islands.......	92	27,035	43,138	37	8,261	129	51,399
Portuguese............	48	32,642	51,217	152	50,087	200	101,304
Russian...............	573	354,539	578,343	726	231,305	1,299	809,648
Spanish...............	459	461,333	720,822	136	43,625	595	764,447
Swedish...............	750	308,623	502,581	764	218,535	1,514	721,116
Turkish...............	125	57,970	92,869	216	61,625	341	154,494
Other countries.........	.....	....	23,330	15	5,333	47	28,663
Total, including countries not specified....	17,761	16,822,466	27,183,365	12,182	6,459,766	29,943	33,643,131

THE WORLD'S LARGE AND FAST OCEAN STEAMSHIPS.

The following table shows the sea-going screw steamships in the world of 12 knots or upward, and of 2,000 gross tons or more, recorded in Lloyd's Register on July 1, 1903, including a few vessels building at that time. While in tonnage these vessels are about one-fourth of the world's sea-going steam tonnage, in efficiency, due to their size and speed, they represent more nearly one-third of the effective ocean-carrying power of the world in the general foreign and colonial carrying trade, and probably 85 per cent. of the world's foreign passenger trade.

Speed.	1903.	
	Number.	Tons.
Twenty knots and over.....	20	236,114
Under 20 and over 19 knots.	9	63,219
Under 19 and over 18 knots.	24	191,454
Under 18 and over 17 knots.	56	378,197
Under 17 and over 16 knots.	80	550,315
Under 16 and over 15 knots.	98	509,479
Under 15 and over 14 knots.	154	766,719
Under 14 and over 13 knots.	379	1,886,602
Under 13 and over 12 knots.	502	2,079,775
Total...............	1,322	6,661,874



Japanese 700,000	Italian 1,200,000	Norwegian 1,700,000	German 3,000,000
Russian 1,000,000	French 1,500,000	United States 2,800,000	British 15,000,000

COMPARATIVE MERCHANT MARINE OF THE FIRST EIGHT MARITIME NATIONS OF THE WORLD.
TONNAGE EXPRESSED IN ROUND FIGURES.

The following table classifies these vessels in 1903, according to speed and flag:

Flag.	Speed in Knots.									
	20	19	18	17	16	15	14	13	12	Total.
British	7	....	17	25	40	38	80	197	308	712
German	5	2	3	....	7	8	9	38	68	140
American	4	....	3	9	15	26	27	28	17	129
French	2	2	....	19	5	1	3	42	39	113
Russian	2	4	....	....	2	2	....	2	20	32
Spanish	....	1	....	....	2	2	5	6	7	23
Roumanian	....	....	1	....	....	....	....	....	....	1
Italian	....	....	....	....	1	9	6	10	12	38
Japanese	....	....	....	3	2	3	7	24	6	45
Austro-Hungarian	....	....	....	....	2	3	2	11	6	24
Danish	....	....	....	....	3	....	....	....	....	3
Dutch	....	....	....	....	....	5	6	3	14	28
Belgian	....	....	....	....	1	1	....	9	2	13
Chilean	....	....	....	....	....	....	9	....	1	10
Portuguese	....	....	....	....	....	....	....	6	....	6
Brazilian	....	....	....	....	....	....	....	3	....	3
Argentine	....	....	....	....	....	....	....	....	2	2
Total	20	9	24	56	80	98	154	379	502	1,322

MOTIVE POWER AND CHIEF MATERIALS OF CONSTRUCTION OF THE WORLD'S MERCHANT MARINE.

MOTIVE POWER.

Year.	Total Vessels.		Steam.			Sail.	
	Number.	Tons.	Number.	Gross Tons.	Net Tons.	Number.	Net Tons.
1890	32,298	22,151,651	11,108	12,985,372	8,295,514	21,190	9,166,279
1895	30,368	25,107,632	13,256	16,887,971	10,573,642	17,112	8,219,661
1900	28,422	29,043,728	15,898	22,369,358	13,856,513	12,524	6,674,370
1903	29,943	33,643,131	17,761	27,183,365	16,822,466	12,182	6,459,766

Recorded in Lloyd's, 100 tons or over.

CONSTRUCTION.

Year.	Total Vessels.		Steam.		Sail.	
	Number.	Tons.	Number.	Gross Tons.	Number.	Net Tons.
1890	1,362	1,646,809	880	1,328,541	482	318,268
1895	794	1,211,615	629	1,114,019	165	97,596
1900	1,285	2,268,938	966	2,046,339	319	222,599
1902	1,336	2,346,315	900	2,218,600	436	285,340

Vessels built in the world (over 100 tons), according to Lloyd's (including vessels not recorded in Lloyd's).

FOREIGN CARRYING TRADE—UNITED STATES.

The following statement of the value of imports and exports carried in United States and in foreign vessels, and the tonnage of entries and clearances from 1821 to 1903, is furnished by the Bureau of Statistics, Treasury Department:

Fiscal Year—	Imports.			Exports.		
	In Cars and Other Land Vehicles.	In American Vessels.	In Foreign Vessels.	In Cars and Other Land Vehicles.	In American Vessels.	In Foreign Vessels.
1821	....	$58,025,890	$4,559,825	....	$55,175,572	$9,798,410
1825	....	91,902,512	4,437,563	....	88,709,749	10,735,639
1830	....	66,035,739	4,481,181	....	63,882,719	9,966,789
1835	....	135,288,865	14,606,877	....	94,135,191	27,558,386
1840	....	92,802,352	14,339,167	....	105,622,257	26,463,689
1845	....	102,438,481	14,816,083	....	86,942,442	27,704,164
1850	....	139,657,043	38,481,275	....	99,615,041	52,283,679
1855	....	202,234,900	59,233,620	....	203,250,562	71,906,284
1860	....	228,164,855	134,001,399	....	279,082,902	121,039,394
1865	....	74,385,116	174,170,536	....	93,017,756	262,839,588
1870	....	153,237,077	309,140,510	....	199,732,324	329,786,978
1875	$13,083,859	157,872,726	382,949,568	$7,304,376	156,385,066	501,838,949
1880	15,142,465	149,317,368	503,494,913	5,838,928	109,029,209	720,770,521
1885	21,149,476	112,864,052	443,513,801	24,183,299	82,001,691	636,004,765
1890	40,621,361	124,948,948	623,740,100	32,949,902	77,502,138	747,376,644
1895	33,201,988	108,229,615	590,538,362	49,902,754	62,277,581	695,357,830
1900	44,412,509	104,304,940	701,223,735	110,483,141	90,779,252	1,193,220,689
1903	66,208,195	123,666,832	835,844,210	138,851,301	91,028,200	1,190,258,178

Note.—The amounts carried in cars and other land vehicles were not separately stated prior to July 1, 1870. Exports are stated in mixed gold and currency values from 1862 to 1869 inclusive.

PANAMA ROUTE.

The following table shows the distances by the proposed Panama route from some of the principal seaports of North and South America, Europe and Africa, to San Francisco and Valparaiso.

(Nautical miles.)

From	Panama Route, San Francisco.	Panama Route, Valparaiso.	From	Panama Route. San Francisco.	Panama Route. Valparaiso.
Halifax	5,604	5,210	Hamburg	8,423	7,729
Portland	5,471	4,781	Bremen	8,419	7,725
Boston	5,425	4,735	Amsterdam	8,202	7,508
New York	5,278	4,584	Antwerp	8,172	7,478
Philadelphia	5,267	4,573	Havre	7,959	7,265
Baltimore	5,320	4,626	Marseilles	8,367	7,673
Charleston	4,915	4,221	London	8,145	7,451
Savannah	4,920	4,226	Liverpool	7,907	7,213
Key West	4,428	3,744	Glasgow	7,890	7,186
Pensacola	4,696	4,002	Dublin	7,823	7,129
Mobile	4,723	4,029	Lisbon	7,502	6,813
New Orleans	4,732	4,038	Gibraltar	7,677	6,983
Galveston	4,833	4,139	Barcelona	8,191	7,497
Havana	4,365	3,671	Naples	8,663	7,969
San Juan (P. R.)	4,335	3,641	Trieste	9,358	8,664
Buenos Ayres	8,732	8,038	Constantinople	9,514	8,820
Montevideo	8,632	8,038	Alexandria	9,482	8,788
Rio Janeiro	7,642	6,948	Port Said	9,610	8,916
St. Petersburg	9,238	8,544	Palermo	8,605	7,911
Stockholm	8,940	8,246	Free Town	7,160	6,468
Copenhagen	8,503	7,809	Cape Town	9,760	....

* New York to San Francisco via Magellan Straits, 13,090.

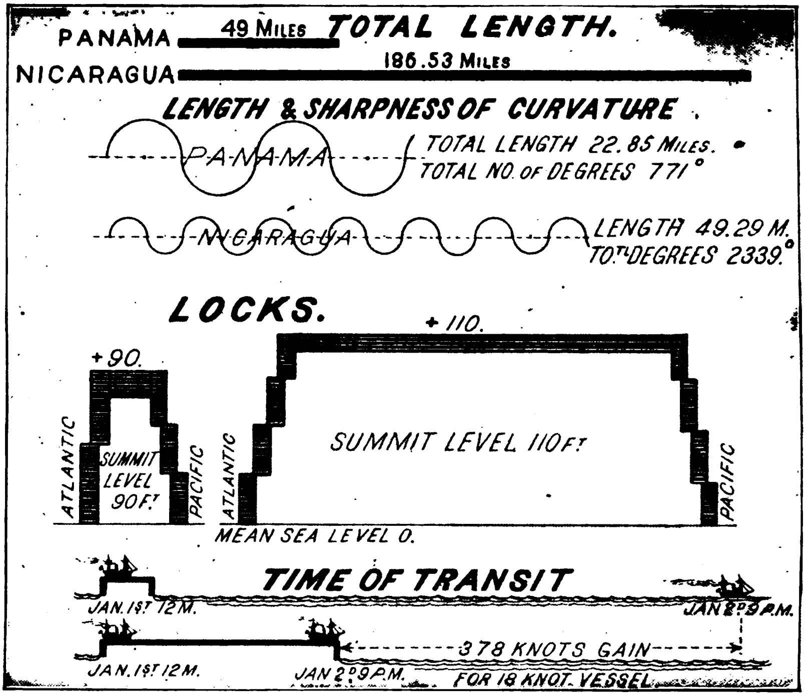


DIAGRAM SHOWING SUPERIOR ADVANTAGES OF THE PANAMA CANAL OVER THE NICARAGUA CANAL.

PANAMA, SUEZ, AND CAPE OF GOOD HOPE ROUTES.

The following table gives the distance from New York to ports named by the routes specified:

From	Via Panama.	Via Suez.	Via Cape of Good Hope.
New York to—			
Tientsin.....	10,908	12,914	15,063
Shanghai....	10,828	12,187	14,446
Tokyo......	9,692	13,019	15,178
Manila......	11,412	11,435	13,555
Melbourne...	9,911	12,737	12,206

There are 47 steamships engaged in cable-laying and repairing.

The longest submarine telephone cable is on the London-Brussels route. It extends from St. Margaret's Bay to La Panne, a distance of 54 miles.

WORLD'S OUTPUT OF TONNAGE.

Countries.	1903.	1902.
	Tons.	Tons.
United Kingdom......	1,409,630	1,619,040
Germany............	261,003	272,350
United States.........	493,144	314,900
Holland.............	71,423	91,120
France..............	107,431	189,930
Italy...............	52,380	49,900
Norway and Sweden..	61,057	34,330
Belgium.............	17,301	14,560
Denmark............	23,849	22,440
Austria-Hungary......	37,208	20,900
Russia..............	63,726	2,740
Spain and Portugal....	2,040	2,040
Greece..............	72	200
Canada.............	13,252	13,500
Japan (European).....	35,411	35,570
China (European).....	6,631	3,820
Hongkong (European).	4,309	....
Singapore (European)..	2,379	3,000
Other countries.......	16,000	10,000

—*London Statist.*

DIMENSIONS OF THE LARGEST FAST OCEAN STEAMERS.

The largest and in many respects the highest type of marine architecture is to be found in the modern ocean greyhound for transatlantic trade. In recent years the rival companies have vied with each other in the effort to excel, and steamships of larger size, greater speed, and more perfect equipment have followed each other, until it would seem that the limit had been reached. In the accompanying table the largest and most recent steamers are placed in comparison with the "Great Eastern."

Name of Ship.	Date.	Length over All.	Beam.	Depth.	Draught.	Displacement.	Maximum Speed.
		Feet.	Feet.	Feet.	Feet.	Tons.	Knots.
Great Eastern.	1858	692	83	57¼	25¼	27,000	12
Paris.	1888	560	63	42	26½	13,000	20
Teutonic	1890	585	57½	42	26	12,000	20
Campania	1893	625	65	41½	28	19,000	22
St. Paul	1895	554	63	42	27	14,000	21
Kaiser Wilhelm der Grosse.	1897	649	66	43	29	20,000	22.35
Oceanic.	1899	704	68	49	32½	28,500	20
Deutschland.	1900	686½	67¼	44	29	22,000	23.5
Baltic	1904	725¾	75	49	30¼	40,000	20

SPEEDS OF OCEAN GREYHOUNDS.

The following tables show the fast recorded times in which journeys have been made between English ports and those of the United States, Canada, India, China, Burmah, Australia, South Africa, and the West Indies.

The Atlantic Record.	Line or Company.	Timing of Record Run taken between	Distance, Nautical Miles.	Record Run.	Speed, Knots per Hour.
				D. H. M.	
Deutschland (16,500).	Hamburg-American.	New York (Sandy Hook) and Plymouth (off Eddystone).	2,982	E. 5 7 38	23.36
Kronprinz Wilhelm (15,000).	North-German Lloyd.	New York (Sandy Hook) and Plymouth.	2,978	E. 5 8 18	23.21
Kaiser Wilhelm II.	North-German Lloyd.	New York (Sandy Hook) and Plymouth (off Eddystone).	3,112	E. 5 11 58	23.58
Lucania (12,952)	Cunard.	Queenstown (Daunt's Rock) and New York.	2,779	W. 5 7 23	21.81
St. Paul (11,629)	American.	Southampton and New York.	3,046	W. 6 0 31	21.08
Teutonic (10,000).	White Star.	Queenstown (Daunt's Rock) and New York.	2,778	W. 5 16 31	20.34
Minneapolis (13,402).	Atlantic Transport	(Off) Dover and New York (Sandy Hook).	3,265	W. 8 2 31	16.80
New England (11,400).	Dominion.	Queenstown (Daunt's Rock) and Boston Light.	2,636	W. 6 12 42	16.62
Tunisian (10,576).	Allan.	Rimouski and Moville (Ireland) via Belle Isle.	2,307	E. 6 5 20	15.5

E. = Sailing eastward. W. = Sailing westward. —*Daily Mail Year Book*, 1904

RECORD OF ATLANTIC PASSENGER SERVICE TO NEW YORK.

Year.	No. of Passages.	Cabin.	Steerage.	Total.	Year.	No. of Passages.	Cabin.	Steerage.	Total.
1896	852	99,223	252,350	351,573	1900	838	137,852	403,491	541,343
1897	901	90,932	192,004	382,936	1901	887	128,143	438,868	567,011
1898	812	80,586	219,651	300,237	1902	922	139,848	574,276	714,124
1899	826	107,415	303,762	411,177					

—*Daily Mail Year Book*, 1904.

RETURN OF PASSENGERS LANDED AT NEW YORK BY FIVE PRINCIPAL LINES.

Line.	1902.		1901.		1900.	
	Cabin.	Steerage.	Cabin.	Steerage.	Cabin.	Steerage.
North-German Lloyd......	27,767	110,697	22,960	101,384	26,577	92,143
Hamburg-American........	20,698	98,988	20,977	78,560	23,657	72,245
White Star..............	18,402	40,225	18,167	30,483	14,948	29,370
Cunard..................	16,308	23,650	17,783	19,943	20,000	22,751
American................	14,456	20,658	12,110	12,511	16,435	16,884

—*Daily Mail Year Book*, 1904.

FIRST STEAMBOATS, PIONEER SAILINGS, AND EARLIEST LINES.

1707. Denis Papin experimented on River Fulda with paddle-wheel steamboat.

1736. Jonathan Hulls patented designs similar to modern paddle boat.

1769. James Watt invented a double-acting side-lever engine.

1783. Marquess of Jouffrey made experiments in France.

1785. James Ramsey, in America, propelled a boat with steam through a stern-pipe.

1785 Robert Fitch, in America, propelled a boat with canoe-paddles fixed to a moving beam.

1787. Robert Miller, of Edinburgh, tried primitive manual machinery.

1788. Miller, with Symington, produced a double-hull stern-wheel steamboat.

1802. *Charlotte Dundas*, the first practical steam tugboat, designed by Symington.

1804. *Phœnix*, screw-boat designed by Stephens in New York; first steamer to make a sea voyage.

1807. *Clermont*, first passenger steamer continuously employed; built by Fulton in U. S.A.

1812. *Comet*, first passenger steamer continuously employed in Europe; built by Miller in Scotland.

1818. *Rob Roy*, first sea-trading steamer in the world, built at Glasgow.

1819. *Savannah*, first auxiliary steamer, paddle wheels, to cross the Atlantic; built in New York.

1821. *Aaron Manby*, first steamer (English canal boat) built of iron.

1823. City of Dublin Steam Packet Co. was established.

1824. General Steam Navigation Co. was established at London.

1824. George Thompson & Co. (Aberdeen Line), were established.

1825. *Enterprise* made the first steam passage to India.

1825. *William Fawcett*, pioneer steamer of the P. & O. S. N. Co.

1830. T. & J. Harrison (Harrison Line) were established at Liverpool.

1832. *Elburkah*, iron steamer, took a private exploring party up the Niger.

1834. Lloyd's Register for British and Foreign Shipping established.

1836. Austrian Lloyd Steam Navigation Co. established at Trieste.

1837. *Francis B. Ogden*, first successful screw tugboat; fitted with Ericsson's propeller.

1838. *Archimedes*, made the Dover-Calais passage under two hours, fitted with Smith's propeller.

1838. *R. F. Stockton*, built for a tugboat, fitted with Ericsson's propeller, sailed to America; first iron vessel to cross the Atlantic; first screw steamer used in America.

1839. *Thames*, pioneer steamer of the Royal Mail Steam Packet Co.

1839. George Smith & Sons (City Line) were established at Glasgow.

1840. *Britannia*, pioneer steamer of the Cunard Line.

1840. *Chile*, pioneer steamer of the Pacific Steam Navigation Co.

1845. *Great Britain*, first iron screw steamer, precursor of modern Atlantic steamer.

1845. Thos. Wilson, Sons & Co., Ltd. (Wilson Line), established at Hull.

1847. Pacific Mail Steamship Co. established in America.

1849. Houlder Brothers & Co. established at London.

1850. Bullard, King & Co. (Natal Line) established at London.

1850. Messageries Maritimes de France established.

1850. Inman (now American) Line, established at Liverpool.

1851. *Tiber*, first steamer of the Bibby Line, established 1821 at Liverpool.

1852. *Forerunner*, pioneer steamer of the African Steamship Co.

1853. Union Steamship Co. was established (now Union-Castle Line.)

1853. *Borussia*, first steamer of the Hamburg-American Packet Co., established 1847.

1854. *Canadian*, first steamer of the Allan Line, established 1820.

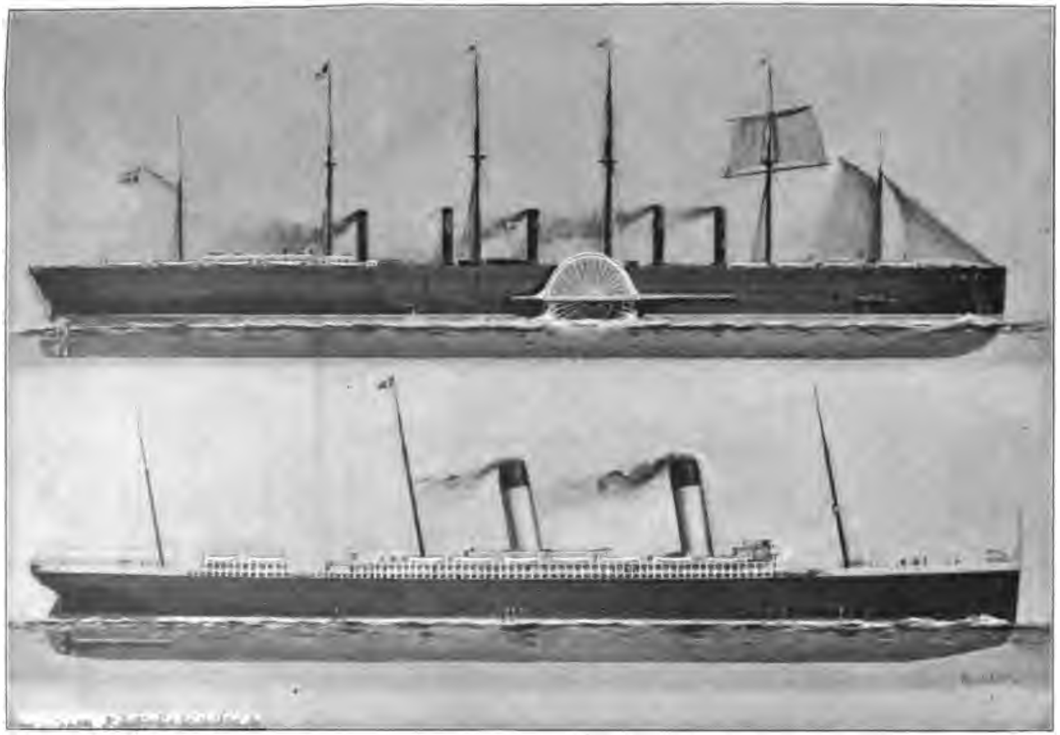
1855. British India Steam Navigation Co. was established.

1856. *Tempest*, first steamer Anchor Line.

1858. *Bremen*, first Atlantic steamer of the Norddeutscher Lloyd, established 1856.

1858. *Great Eastern* launched into the Thames. Jan. 31; commenced, May 1. 1854.

—*Whittaker's Almanac.*



"Great Eastern"	Length over all, 692 ft.;	beam, 83 ft.;	depth, 57½ ft.;	displacement on 25½ ft. draught,	27,000 tons;	horse power, 8,000;	maximum speed, 14½ knots.
"Oceanic"	" " " 704 "	" 68 "	" 49 "	" " 32½ "	" 28,500 "	" " 28,000;	" " 21¼ "

"GREAT EASTERN" AND "OCEANIC" COMPARED.

NUMBER OF VESSELS OVER 5,000 TONS EACH, AND PARTICULARS OF LARGEST VESSELS BELONGING TO EACH COUNTRY.

Country.	No.	Ship's Name.	Gr. Tons.	Speed.	Owners.
Austria.	7	Austria.	7,588	12½	Austrian Lloyd.
Belgium. . . .	2	Vaderland	11,899	16	Red Star Line.
Brazil.	—	Rio Gallejos.	2,987	*	Hamburg S. American SS. Co.
Chile.	1	Rancajua.	5,975	*	S. American Nav. Co.
Denmark. . .	5	United States.	10,100	16	Forende Dampskibs, Copenhagen.
France.	39	La Savoie.	11,884	21	Compagnie Gén. Transatlantique.
Germany. . .	139	Kaiser Wilhelm II.	19,036	23½	Norddeutscher Lloyd.
Gr. Britain. .	437	Cedric.	21,035	17	White Star Line.
Greece	—	Keramiac.	4,700	*	M. S. Vagliano.
Holland. . . .	13	Noordam.	12,531	15	Holland-American Line.
Italy.	8	Il Piemonte.	6,025	*	L. Capuccio & Co.
Japan.	21	Aki Maru.	6,444	14	Nippon Yusen Kaisha.
Norway. . . .	—	Afton	4,434	*	McLaren & McLaren.
Russia	14	Moskva.	7,297	20	Russian Vol. Fleet Assn.
Spain.	9	Alfonso XII.	6,875	19	Compañia Transatlantica.
Sweden.	2	Kronprins Gustaf. .	5,383	*	A. Johnson.
UnitedStates	54	Minnesota	21,000	*	Gt. Northern Steamship Co.
Total. . . .	751	* Under 12 Knots.			

FROM STEAM PACKET TO STEAM PALACE.

(1) Wood Paddle-boats. (2) Iron " (3) Iron Screw Steamers. (4) Steel " " (5) Steel Twin-Screw Steamers.

Date	Name of Steamer.	Owners.	Remarks.
1833	Royal William. . . (1)	Quebec & HalifaxS.N.Co.	From Pictou (N.S.), 1st to cross the Atlantic.
1838	Sirius.	British and Amer.S.N.Co. .	From Cork, 1st departure from U. K.
"	Great Western.	Great Western S.N.Co. . . .	" Bristol, 1st built for Atlantic.
"	Royal William (2). . .	Transatlantic SS. Co.	" Liverpool, 1st departure.
1840	Britannia.	Cunard Line	" Liverpool,1st carriedBritish mails.
1849	Atlantic.	Collins "	" New York, 1st carried U.S. mails.
1854	Canadian.	Allan "	" Glasgow, 1st steamer of Line.
1856	Tempest.	Anchor "	" " 1st " "
"	Borussia.	Hamburg-American Line .	" Hamburg,1st " "
"	Adriatic.	Collins Line.	Last Sailing of Line.
1858	Bremen.	Norddeutscher Lloyd.	From Bremen to New York.
1856	Persia . . . . (2)	Cunard.	1st Cunard iron paddle steamer.
1862	Scotia.	"	Last " " " "
1845	Great Britain. . . . (3)	Great Western S.N.Co. . . .	1st Atlantic iron screw steamer.
1850	City of Glasgow.	Inman Line.	1st to carry steerage passengers.
1858	Great Eastern. . . .	East.and Australian SS.Co.	Paddle wheels and propeller.
1868	Italy.	National Line.	1st Atlantic ss. with comp. engines.
1869	City of Brussels. . . .	Inman "	1st " " " steam steering gear.
1871	Oceanic (1st).	White Star Line	1st with'midship saloon, &c.
1873	Pennsylvania.	American "	1st sailing of Line to Liverpool.
1874	Britannic.	White Star "	1st to exceed 5,000 tons, Great Eastern [excepted.
1875	City of Berlin.	Inman "	1st with electric light.
1879	Arizona.	Guion. . "	Watertight compartments floated her.
1882	Alaska.	" "	1st "ocean greyhound."
1883	Oregon.	" " (1). . . . . . Cunard " (2).	Sunk outside New York; every one saved by N. D. Lloyd ss. Fulda.
1879	Buenos Ayrean. . (4)	Allan Line.	1st Atlantic steel steamer.*
1881	Servia.	Cunard "	1st Cunard " "
"	City of Rome.	Inman (1) Line. . . . . . . Anchor(2) "	Fitted with three funnels.
1884	America.	National "	1st and last express ss. of Line.
"	Umbria. . . . . Etruria.	Cunard "	1st with 20 knots speed.
1886	Aller.	Norddeutscher Lloyd.	1st triple-expansion express ss.†
1888	City of NewYork(5) City of Paris.	Inman & International(1) American Line (2)	1st twin-screw ocean expresses.‡ 1st to exceed 10,000 tons,G.E.excepted
1889	Teutonic. . . . . Majestic.	White Star Line.	Designed as mercantile cruisers.
1890	Fürst Bismarck.	Hamburg-American Line .	1st under 6½ days from Southampton.
1892	La Touraine.	Compagnie Générale Trans.	Record Havre to New York, 6¾ days.

FROM STEAM PACKET TO STEAM PALACE—*Continued.*

Date	Name of Steamer.	Owners.	Remarks.
1893	Campania Lucania	Cunard Line	Lucania: highest day's run 562 knots. Liverpool to New York records.
1895	St. Paul St. Louis	American	Largest express steamers ever built in America.
1897	KaiserWilhelm d. Gr.	Norddeutscher Lloyd	Record day's run, 580 knots.
1899	Oceanic	White Star Line	Balanced engines. 1st to exceed 15,000 tons.
1900	Deutschland	Hamburg-American Line	Fastest ocean steamer in the world.
1901	CELTIC	White Star Line	1st to exceed 20,000 tons.
1902	KRONPRINZ WILHELM	Norddeutscher Lloyd	
1903	Kaiser Wilhelm II	Norddeutscher Lloyd	Largest express steamer in the world.
1904	Baltic	White Star Line	Largest ss. in the world—726x76x49.

* Union Co. of N.Z.'s Rotomohana, 1,763 tons, was first ocean steel ss. 1879.
† Martello, 2,432 tons, of Wilson Line, was first Atlantic cargo triple-expansion ss. 1884.
‡ Notting Hill, 3,921 tons, of Twin-screw Cargo Line, came out so engined, 1881.

REDUCTION OF PASSAGE.

	Days.		Tons.
1862.	Under 9 from Q'town,	Scotia	3,871
1869	" 8 " "	CityofBruss'.	3,081
1882.	" 7 " "	Alaska	6,400
1889.	" 6 " "	City of Paris	10,669
1894.	" 5½ " "	Lucania	12,950
1897.	" 6 " S'ton.	Kaiser Wilhelm der Gr	14,349
1903.	" 5½ " Cherb'g	Deutschland	16,502

PROGRESS IN LENGTH.

		Feet.		Tons.
1838,	1st to exceed	200	Great Western	1,340
1845	" "	300	Great Britain	2,084
1858	" "	680	Great Eastern	18,918
1871	" "	400	Oceanic (1).	3,807
1881	" "	500	Servia	7,392
1893	" "	600	Campania	12,952
1899	" "	700	Oceanic (2).	17,247
1904	" "	725	Baltic	23,000

LARGEST STEAMSHIP OWNERS IN THE WORLD.

Owners of over 100,000 gross tons in order of tonnage.

LINES.	Head Office.	Total Tonnage.	Over 20 knots	KNOTS. 20	19	18	17	16	15	14	13	12	Under 12 knots	Total.
Hamburg-American	Hamburg	650,000	1	1	1	1		4	1		7	16	93	125
Norddeutscher Lloyd.	Bremen	583,000	3	1		2		5	7	8	23	23	50	122
Brit. Ind. Steam N.Co.	London	432,000	..				2	5	21	25	23	38	11	125
P. & O. Steam N. Co.	London	349,000	..	2		12	4	4	1	11	11	9	5	59
Union-Castle	London	314,000	..				8	2		2	4	20	13	49
Leyland	Liverpool	281,000	..							6	9	20	12	47
White Star	Liverpool	260,000	1	2			3	2	4	1	13	1	..	27
A. Holt	Liverpool	263,000	..							3	24	13	15	55
NipponYusen Kaisha	Tokio	248,000	..						3	7	23	4	41	78
Messageries Maritimes	Paris	239,000	..				10	4		1	25	7	11	58
Ellerman Lines, Ltd.	Liverpool	237,000	..								6	19	47	72
Elder, Dempster &Co.	Liverpool	236,000	..				1	2	2		11	4	93	113
Wilson	Hull	208,000	..						1	1	12	13	75	102
Navigazione Gen. Ital.	Rome	231,000	..					4	9	2	14	13	65	107
Austrian Lloyd	Trieste	203,000	..					3	3	2	11	11	41	71
Clan	Glasgow	189,000	..								4	21	24	49
Harrison	Liverpool	189,000	..								23	9	5	37
American	Philadelphia	180,000	..	4				4	1	5	3	2	6	25
Canadian Pacific Ry.	Montreal	170,000	..			1		3	1	2	3		13	23
Comp. Géné. Trans.	Paris	169,000	2		2		9	1	6	6	4	7	15	52
Hansa	Bremen	160,000	..										45	45
Pacific Steam N.Co.	Liverpool	151,000	..			1		6	14	6	4	7	3	41
For. Damps. Selskab.	Copenhagen	149,000	..					3	1		4	2	109	119
Atlantic Trans. Co.	London	138,000	..					3	1	7		2	6	19
Anchor	Glasgow	135,000	..					1		2	4	5	18	30
Allan	Glasgow	134,000	..					2	1	1	4	7	15	30
Hamb'g S. American	Hamburg	130,000	..								3	9	20	32
Cunard	Liverpool	129,000	2	2			1	2	1	1	1		9	19
Dominion Line	Liverpool	125,000	..					4	1		3	3	4	15
Lamport & Holt	Liverpool	124,000	..							2	2	14	17	35
Chargeurs Réunis	Paris	115,000	..								4	25	5	34
Kosmos	Hamburg	109,000	..									11	17	28
Prince	Newcastle-on-T.	108,000	..						2			2	36	40
R. Ropner & Co.	West Hartlepool	108,000	..										38	38
Royal Mail S. P. Co.	London	105,000	..				8	3			1	5	19	36
Deutsch-Australische.	Hamburg	105,000	..										23	23
Russ. Steam N.&T.Co.	St. Petersburg	102,000	..									15	51	66
Shell	London	100,000											33	33

—*Whittaker's Almanac.*

OCEAN STEAMERS. 16 Knots and over. Number belonging to each Country.

Country.	20 knots & above.	19 knots.	18½ kts.	18 knots.	17½ knots.	17 kts.	16 knots.	Total.
Austria	..	..	..	..	..	..	2	2
Belgium	..	..	..	..	..	..	1	1
France	..	2	..	..	12	7	..	21
Denmark	..	..	..	..	..	..	3	3
Germany	5	2	1	1	..	..	4	13
Great Britain	9	..	1	15	8	17	40	90*
Italy	..	..	..	..	..	..	4	4
Japan	..	..	..	..	..	3	2	5
Russia	2	4	..	..	..	..	2	8
Spain	..	1	..	..	..	..	2	3
United States	5	..	..	3	2	12	18	40
	21	9	2	19	22	39	78	190

*P. & O., 21; R. Mail, 11; Union-Castle, 10; White Star, 8; Cunard, 7; Pacific S. N. Co., 7; Orient, 5; Atlantic Transport Co., 3; Dominion, 3; Elder, Dempster, 3; Canadian Pac. Rail., 3; Union of N. Zealand, 3; Allan, 2; Khedivial Mail Co., 2; Anchor, 1; International Nav. Co., 1. N.B.—There were on June 30, 1903, only 1,446 ocean steamers in the world capable of a sea-speed of at least 12 knots per hour, of which 751 were British. See article on "Baltic" on page 32.

OCEAN STEAMERS. 20 Knots and over. In order of Tonnage.

Built in	Names.	Owners.	Gross Tons.	Dimensions.	Spd.	Builders.
1902	* Kaiser Wilhelm II	N.D. Lloyd	19,360	678x72x38	23¼	Stettin V. Co.
1899	Oceanic	White Star	17,274	685x68x44	21	Harland&W.
1900	Deutschland	Hamburg-American	16,502	662x67x40	23½	Stettin V. Co.
1901	Kronprinz Wilhelm	N. D. Lloyd	14,908	640x66x43	23	"
1897	Kaiser Wilhelm der Grosse	"	14,349	627x66x35	22½	"
1893	Campania	Cunard	12,950	601x65x37	22	Fairfield.
1893	Lucania	"	12,950			
1897	Kaiser Friedrich	F. Schichau	12,480	581x63x44	22	Schichau.
1900	La Lorraine	Com. Gén. Trans.	11,869	563x60x35	20	Owners.
1900	La Savoie					
1895	St. Louis	International Mercantile Marine. Co.	11,864	535x63x37	21	Cramp&Sons.
1895	St. Paul		11,629			
1888	New York	"	10,798	527x63x22	20	Clydebank.
1889	Philadelphia (ex Paris)	"	10,786			
1890	Majestic	White Star	10,147	565x58x39	20	Harland&W.
1889	Teutonic	"	9,984			
1890	Kaiserin Maria Theresa	N. D. Lloyd	8,278	528x51x36	20	Stettin V.Co.
1884	Umbria	Cunard	8,128	501x57x38	20	Fairfield.
1884	Etruria	"	8,120			
1898	Moskva	Russ. Vol. Flt. Assoc.	7,297	487x58x26	20	Clydebank.
1898	Smolensk	" "	7,270			
1898	Isis	P. & O.	1,728	300x37x17	20	Caird & Co.
1898	Osiris					

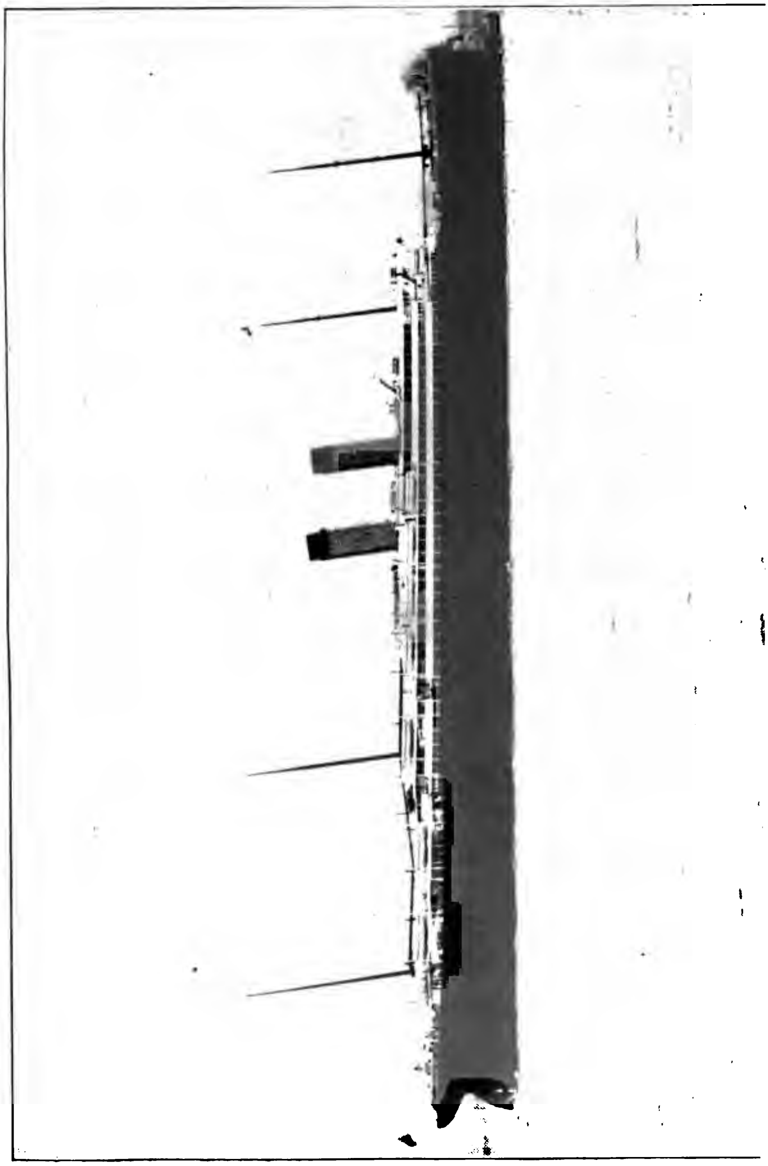
* *Kaiser Wilhelm II.* H. P. 38,000; room for 775 1st class, 342 2d class, and 770 3d class passengers and crew of 620.

SHORT TRIP STEAMERS (British and Foreign). 20 Knots and over.

British Boats.		Owners.
*Connaught, Leinster, Munster, Ulster, all 23¼ knots	4	City of Dublin Steam Packet Co.
Empress Queen 22, Pr. of Wales 21, Queen Vict'ia 21	3	Isle of Man Steam Packet Co.
France 21½, Sussex, Tamise, Manche, all 21½, Arundel	5	London, B. &. S. C. Railway.
Brighton (turbine engines)	1	London B. & S. C. Railway.
Banshee 21, Cambria, Anglia, Hibernia, Scotia	4	London & North-Western Railway.
Britannia, Cambria, Westward Ho	3	P. A. Campbell, Ltd.
La Marguerite 20½, Royal Sovereign	2	Fairfield S. & E. Co., Ltd.
King Edward (turbine engines), Queen Alexandra	2	John Williamson.
Total	24	

Foreign Boats.		
Belgian Government: 3, 22 kts.; 3, 21 kts.	6	Dover—Ostend Service.
Cie. des Chemins de Fer du Nord of France	2	Dover—Calais Service.
Zeeland Steamship Co. of Holland	3	Queensborough—Flushing Service.
Central Railroad Co., New Jersey, U. S.	1	New York—The Highlands.
Total	12	

* The four fastest short-trip steamers in the world. —*Whittaker's Almanac.*



THE NEW WHITE STAR LINER "BALTIC" — THE LARGEST VESSEL IN THE WORLD.

THE FOUR UPPER DECKS OF THE "BALTIC."

The success of the "Oceanic" showed that the most remunerative type of craft for the transatlantic traffic is the vessel of a medium speed, maintained under all varying conditions, but of a tremendous tonnage. Although speed may be an important desideratum from one point of view, such a qualification is in reality only appealing to a limited quota of passengers, the bulk of travelers preferring greater comfort and steadiness of the vessel, especially in rough weather. Each of the two vessels built after the "Oceanic" has marked an increase in size and tonnage upon its predecessor.

The latest liner, the "Baltic," surpasses in size anything that has thus far been attempted, though it is by no means the finite, for Messrs. Harland & Wolff have declared their readiness to build a vessel of 50,000 tons. The realization of such a vessel is dependent upon the capacity of a dock to accommodate it.

The length of the "Baltic" over all is 725 feet 9 inches. This is an increase upon the length of the "Celtic" and "Cedric" of 25 feet. The beam is the same, being 75 feet; the depth, 49 feet. The gross tonnage is 23,000 tons, an increase of about 3,000 tons. The cargo capacity is about 28,000 tons, and the total displacement at the load draft approximates 40,000 tons.

The total complement of passengers is 3,000 passengers, and a crew of about 350. The general arrangement of the ship is similar to the other two vessels of this type—a continuous shade deck running fore and aft, with three tiers of deckhouses and two promenade decks above same. On the upper promenade deck is the first-class smokeroom and library, and the two houses below contain the deck staterooms. All the first-class accommodation is situated amidships.

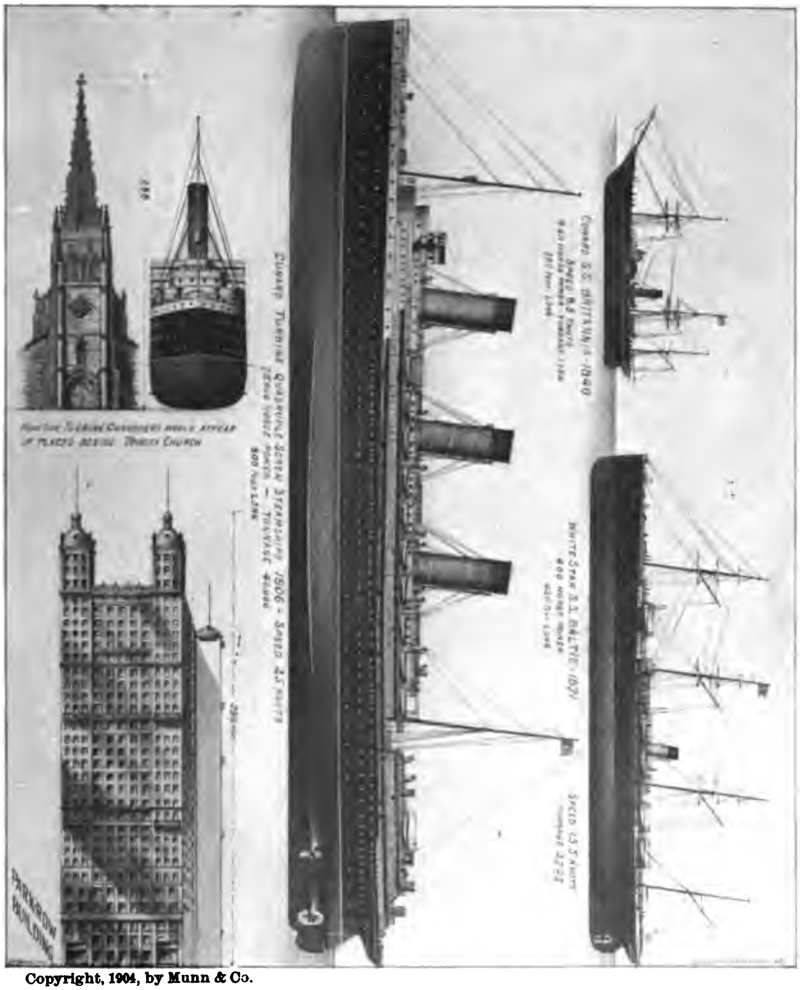
The vessel is not speedy. In the case of the "Oceanic" a speed of 20 knots can be maintained, but in the subsequent vessels this was reduced to about 16½ knots. The "Baltic" will approximate the same speed, with a great reserve of power, to enable this rate of traveling to be maintained even under adverse conditions.

The "Baltic" is fitted with engines of Harland & Wolff's quadruple-expansion type, developing about 13,000 I. H. P. The engines are arranged on the balance principle, which practically does away with all vibration. The twin engines and twin screws afford another element of safety to the ship and passengers, and the possibility of danger is reduced to a minimum.

The maiden trip of the "Baltic" was made without incident. Her trip occupied 7 days 13 hours and 37 minutes. She left Liverpool at 5 P. M. on June 29, 1904, and by 8:21 had passed Rock Light on her way to Queenstown. Her daily runs were: July 1, 312 knots; July 2, 395 knots; July 3, 403 knots; July 4, 417 knots; July 5, 387 knots; July 6, 407 knots; July 7, 414 knots.

The engines ran from seventy-eight to eighty revolutions a minute, while the forty-eight furnaces consumed only 235 tons of coal a day. Her engine and fireroom force is comparatively small—fourteen engineers, fifteen oilers, thirty-six firemen, twenty-six coal passers, two storekeepers, two stewards and one winchman making up the three watches.

Electricity on Shipboard.—Among the later developments of electricity is that on shipboard. The most complete installation of this kind is that on the "Kronprinz Wilhelm." Here all the cabins have telephones, in addition to the electric light, and call bells. The first-class cabins and the dining-room are heated by electric stoves. A system of bulkhead telegraphy enables the captain in a moment of danger, caused by collision, to see, while on the bridge, whether all the water-tight doors are closed. There are forty such doors, and each one falls into place.



THE QUADRUPLE SCREW TURBINE CUNARDERS OF 1906 COMPARED WITH THE PARK ROW BUILDING, TRINITY CHURCH, THE WHITE STAR STEAMSHIP "BALTIC" OF 1871, AND THE FIRST CUNARD STEAMSHIP "BRITANNIA" OF 1840.

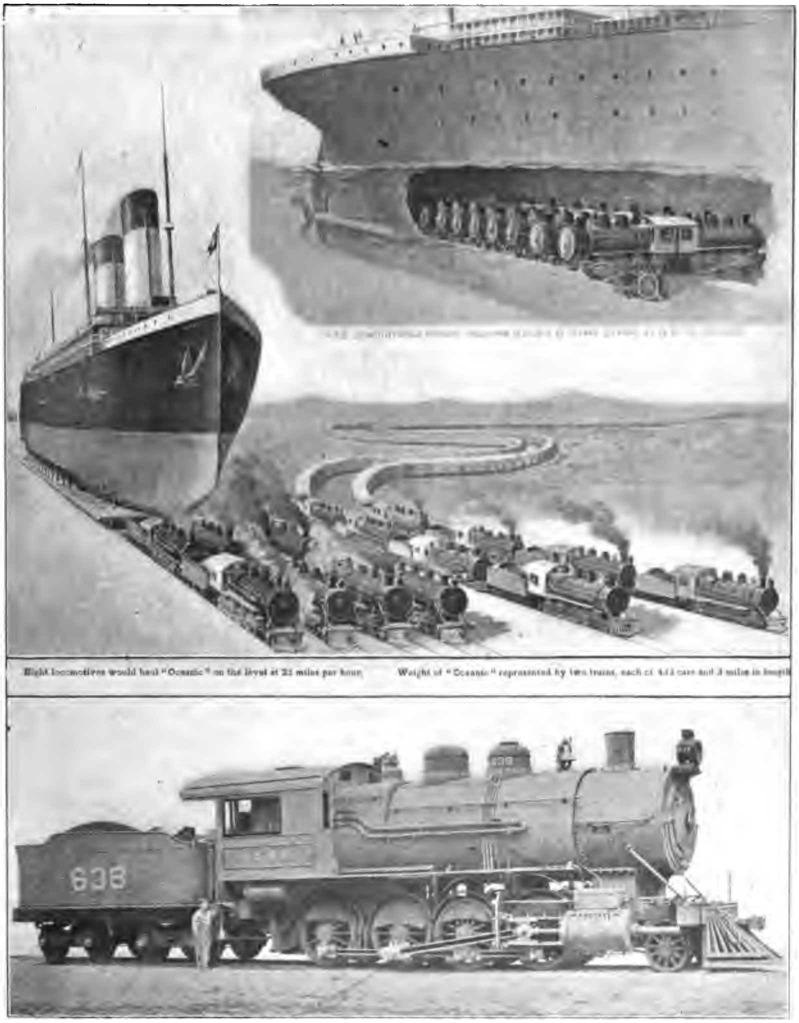
AMERICAN FREIGHT LOCOMOTIVES AND THE ENGINES OF THE "OCEANIC"—A COMPARISON OF HORSEPOWER.

We are told that "Comparisons are odious," and the statement would seem to be based upon a fairly correct estimate of human nature; but as soon as we get outside of the range of human susceptibilities and apply our comparisons to insensate things, comparisons become not only extremely interesting, but at times a valuable means of increasing our general knowledge and our sense of the proper relative proportion of things.

The pictorial comparison to be found here is based upon one of the mammoth freight locomotives which are being turned out in considerable numbers just now by the leading locomotive works of the country. In addition to the usual information as to dimensions and construction, Mr. R. Wells, the superintendent of the Rogers Locomotive Works, has favored us with particulars of some novel experiments which he carried out to determine the exact location of the center of gravity of this locomotive above the rails. He has also given us particulars of its horsepower and freight-hauling capacity on a level road, and it occurs to us that a comparison of the relative power of one of these engines when working up to its maximum indicated horsepower with the maximum indicated horsepower of the "Oceanic," the second largest steamship in the world, will be attractive to that section of our readers that likes to have its facts enlivened occasionally with a touch of the fanciful and curious.

The locomotive shown is an extremely powerful Consolidation which was recently built by the Rogers Company for the Illinois Central Railroad for use on one of the divisions of their line where the grades are somewhat heavier than on the divisions connecting with it. It was designed to haul trains of a maximum weight of 2,000 tons over grades of 38 feet to the mile. The cylinders are 23 inches in diameter, by 30 inches stroke; the drivers are 57 inches in diameter and they carry 198,000 pounds weight of the locomotive out of a total weight of 218,000 pounds. The boiler, which is of the Belpaire type, is 80 inches in diameter at the smoke-box; the fire-box measures 42 inches by 132 inches, and there are 417 2-inch tubes which are 13 feet 8 inches in length. There are 252 square feet of heating surface in the fire-box, and 2,951 square feet in the tubes, making a total heating surface of 3,203 square feet. The tender is exceptionally large, the capacity of the tank being 5,000 gallons, while the coal space has a capacity of 10 tons.

The increase in the diameter of locomotive boilers which has taken place of late years has necessitated their being carried above the tops of the wheels, with the result that the center of the boiler is in some recent locomotives as much as 9 feet above the rails. To the uninitiated these immense machines have an exceedingly top-heavy appearance, and it looks as though their stability would be endangered, especially when they are running at high speed around a curve. Before sending this engine out of the shops, the Rogers Locomotive Company made an experimental test to determine the exact location of its center of gravity. The result is certainly surprising, for although the top of the boiler is fully 9 feet above the rails, the center of gravity was found to be only 50½ inches above the top of the rails, that is to say, about 6½ inches below the top of the driving wheels. As a matter of fact, the great bulk of the boiler is very deceptive to the eye, and one is liable to forget that the greatest concentration of weight lies in the heavy frame, the wheels, the axles, cranks and running gear, and the heavy saddle and cylinder castings. The test was made by suspending the engine on the upper surface of two 3-inch steel pins or journals as pivots, the one at the front being located 6 inches in front of the cylinder saddle, and the one at the rear 6 inches back of the boiler, both pivots being, of course, the same distance above the rails and on the vertical center line of the engine. After several trials, points of suspension were found which were in line with the center of gravity, which, as thus determined, was found to be 50½ inches above the top of the rail. As the bearing points of the drivers on the rails are about 56 inches apart, the base on which the engine runs must be 1.1 times as wide as the height of the center of gravity of the engine above the rails. It is evident from this test that the center of gravity of such a locomotive could be raised still higher without endangering the stability of the engine under the ordinary conditions of service.



A COMPARISON OF MARINE ENGINE AND LOCOMOTIVE POWER.

A COMPARISON OF MARINE ENGINE AND LOCOMOTIVE HORSEPOWER.

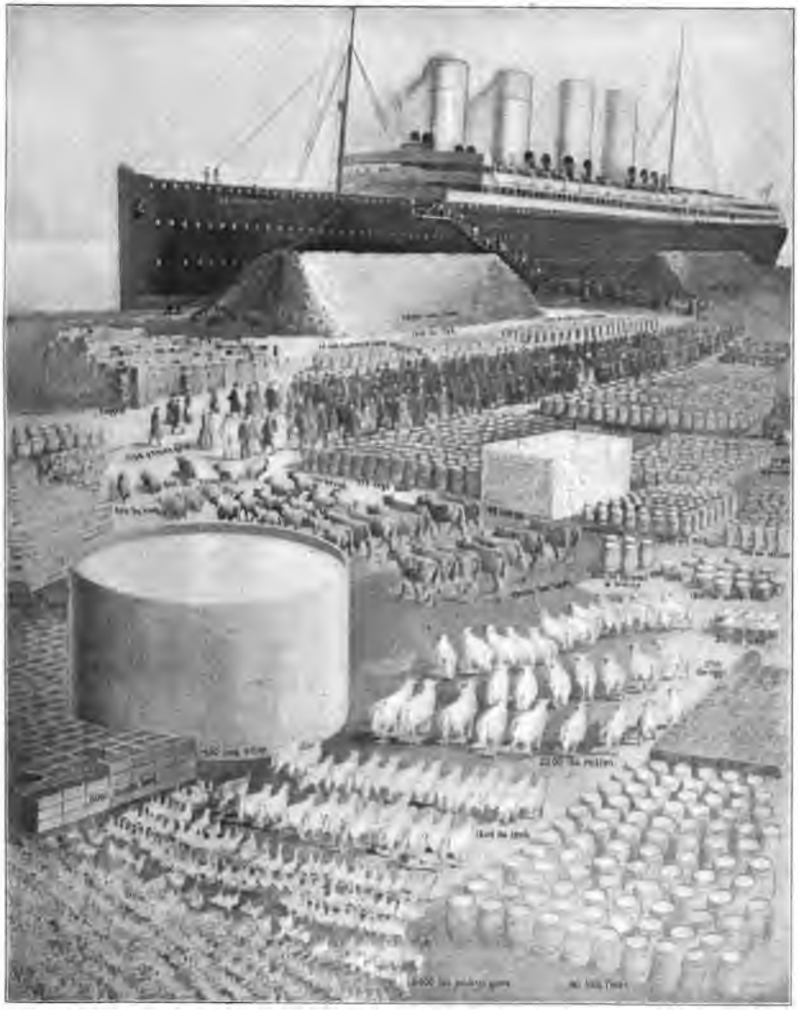
In order to secure a basis for comparison of the power of a modern freight locomotive with that of a modern steamship, we have chosen the "Oceanic." This truly gigantic ship, which exceeds the "Great Eastern" in length and in displacement, is 704 feet in length, and on a draft of 32½ feet displaces 28,500 tons. As the depth of water in the entrance channels to New York Harbor will not accommodate a vessel drawing that amount, for the purpose of this comparison we will suppose that the "Oceanic" is drawing 30 feet, at which draft she would displace about 26,000 tons. On this displacement her engines will indicate about 28,000 horsepower when driving the vessel at a speed of 22 land miles an hour.

Now, it is estimated that the big Rogers Consolidation could haul about 3,250 tons weight of train at a speed of 22 miles an hour, on the level, and that while doing this work it would indicate about 1,760 horsepower. Here then we have a basis of comparison, and we may apply it in two ways. Either we may ask how many of these locomotives would have to be crowded into the hold of the "Oceanic," and coupled to her main shafts, in order to drive her through the water at 22 miles an hour, or we may determine how many of these locomotives it would take to haul the "Oceanic" if she were placed upon a movable cradle of the kind designed by Captain Eads for his Tehuantepec Ship Railway. In the first case, we know that when the main shafts of the "Oceanic" are making about 90 turns a minute, the engines are indicating about 28,000 horsepower, which is their maximum capacity. On the other hand, we know that when the drivers of one of these locomotives are making about 150 turns a minute, and the maximum tractive effort is being exerted at the periphery of the wheels, it is indicating about 1,760 horsepower, which represents its possible maximum indication at that speed. If now the sixteen necessary locomotives (the number being found by dividing the horsepower of the ship by the horsepower of the locomotive) were arranged in two lines, one above each main shaft, and the tractive effort of the drivers transmitted by means of friction wheels to the shafts, the speed of the rotation being reduced by intermediate gearing, in the ratio of 150 to 90, we should have the conditions shown in the engraving on the previous page, where the locomotives, in double phalanx, are shown grinding merrily away at their unwonted task of driving a modern transatlantic liner.

To determine how many Rogers Consolidations it would take to haul the "Oceanic" over a ship railway whose grade is perfectly level, we will neglect the weight of the cradle and assume that its rolling friction is the same as that of a weight of loaded freight cars, equal to that of the ship. The displacement (that is, the weight of the water which the ship displaces at a given draft) on a draft of 30 feet would be about 26,000 tons, and dividing this amount by 3,250 tons, which is the maximum weight of train which one locomotive can haul at 22 miles an hour, we find that it would take just eight locomotives to haul the "Oceanic" by rail at a speed of 22 miles an hour. This result is particularly interesting as showing how quickly the resistance of the water to the motion of the ship increases with the speed. As a matter of fact it increases as the cube of the speed, with the result that, although the "Oceanic" could be moved at a canal-boat speed of 2½ miles an hour by less locomotives than it would take to haul it at that speed on land, at a speed of 22 miles an hour it requires just twice the power on the water that it would on the land.

The "Oceanic," as she rests upon the ship railway cradle, represents both the dead and the live load; that is to say, the ship and the cargo. With a view to showing graphically what an enormous mass is represented by her 26,000 tons displacement, attention is drawn to the sketch showing an equivalent weight in loaded box cars of 40,000 pounds capacity, each of which with its load would weigh about thirty long tons. If this weight were made up into two separate trains each train would contain 433 cars and would be about three miles in length.

Between Brussels and Charleroi there is a length of nearly 30 miles of canal served by overhead wires. The motor "tractors" run on the rough canal towpath, with plain wheels of hard steel. In another style on the Finow and the Tetlow Canals, the "tractor" runs on a single rail by the pair of wheels on one side, and on the towpath by a plain pair of wheels on the other side.



SUPPLIES OF THE "DEUTSCHLAND."

SUPPLIES OF THE "DEUTSCHLAND."

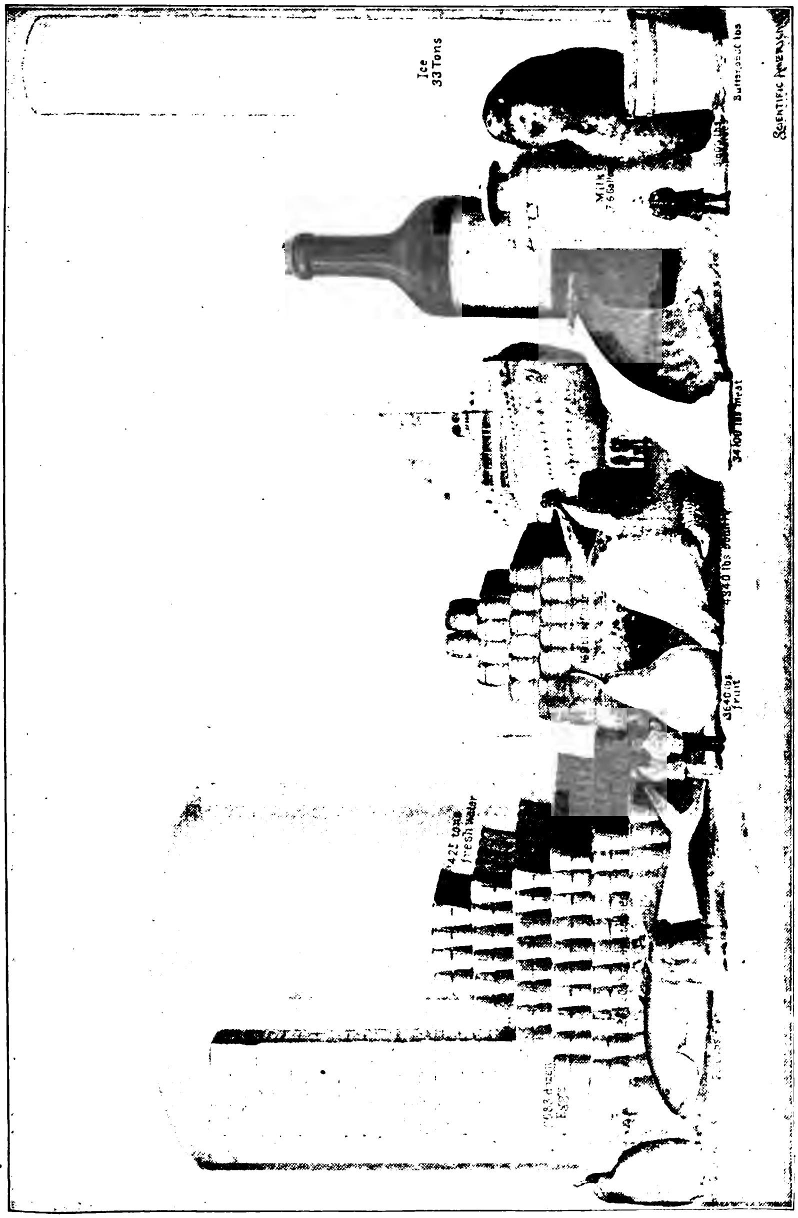
Not by any means the least impressive evidence of the huge size to which the modern transatlantic steamship has grown is to be found in the graphic representation, now presented, of the bewildering amount of provisions that have to be taken aboard for a single trip across the ocean. A mere tabulation of the various kinds of food which go to replenish the ship's larder, during the few days which she spends in port, fails to convey any adequate idea of the vast amount of stores taken aboard. Our pictorial representation is, of course, purely imaginary, particularly as regards the live stock; the beef, mutton, game, etc., being received on the ship in the dressed condition, no live stock whatever being carried. The drawing was made up from a list of the actual amount of provisions carried on a recent eastward trip on the Hamburg-American liner "Deutschland," and the number of live stock which contributed to meet the supplies for one voyage was estimated from the actual number of cattle, sheep, etc., that would be required to make up the total weights in dressed meats. With the exception of the live stock, the provisions are shown in the actual shape in which they would be taken on board.

The dimensions of the vessel are: Length, 686 feet; beam, 67 feet, and displacement, 23,000 tons; her highest average speed for the whole trip is 23.36 knots, and she has made the journey from Sandy Hook to the Lizard in five days seven hours and thirty-eight minutes. In considering the question of feeding the passengers on a vessel of this size, the thought is suggested that here are other hungry mouths within the hull of the ship besides those to be found in the dining saloons of the passengers and the messrooms of the crew; mouths that are so voracious that they require feeding not merely at the three regular meal hours of the ship, but every hour of the day and night, from the time the moorings are cast off at one port until the vessel is warped alongside at the other. We refer to the 112 furnaces in which the fuel of the sixteen boilers in the boiler-room is consumed at the rate of 572 tons per day. Now, although the voyage from New York to Hamburg lasts only six or seven days, according to the state of the weather, the bunkers of the ship are constructed to hold a sufficiently large reserve of coal to cover all contingencies, her total coal capacity being about 5,000 tons; and at each voyage care is taken to see that they are pretty well filled.

The total number of souls on board of the vessel when she has a full passenger list is 1,617, made up of 467 first cabin, 300 second cabin, 300 steerage and a crew of 550, the crew comprising officers, seamen, stewards and the engine-room force. Sixteen hundred and seventeen souls would constitute the total inhabitants of many an American community that dignifies itself with the name of "city," and it is a fact that the long procession which is shown in our illustration, wending its way through the assembled provisions on the quay, by no means represents the length of the line were the passengers and crew strung out along Broadway or any great thoroughfare of that city. If this number of people were to march four deep through Broadway, with a distance of say about a yard between ranks, they would extend for about a quarter of a mile, or say the length of five city blocks.

To feed these people for a period of six days requires, in meat alone, the equivalent of fourteen steers, ten calves, twenty-nine sheep, twenty-six lambs, and nine hogs. If the flocks of chickens, geese and game required to furnish the three tons of poultry and game that are consumed were to join in the procession aboard the vessel, they would constitute a contingent by themselves not less than 1.500 strong. The ship's larder is also stocked with 1,700 pounds of fish, 400 pounds of tongues, sweetbreads, etc., 1,700 dozen eggs and 14 barrels of oysters and clams. The 1,700 dozen eggs packed in cases would cover a considerable area, as shown in our engraving, while the 1,000 brick of ice cream would require 100 tubs to hold them. Of table butter there would be taken on board 1,300 pounds, while the 2,200 quarts of milk would require 64 cans to hold it, and the 300 quarts of cream 8 cans.

In the way of vegetables there are shipped on board 175 barrels of potatoes, 75 barrels of assorted vegetables, 20 crates of tomatoes and table celery, 200 dozen lettuce; while the requirements of dessert alone would call for 4 1-4 tons of fresh fruits. For making up into daily supply of bread, biscuits,



A GRAPHICAL COMPARISON OF THE PROVISIONS OF A TRANSATLANTIC LINER.

cakes, pies, and the toothsome odds-and-ends of the pastry cook's art, there are taken on board at each trip 90 barrels of flour, each weighing 195 pounds, this item alone adding a weight of 8½ tons to the cooks' stores. To this also we must add 350 pounds of yeast and 600 pounds of oatmeal and hominy.

Under the head of liquids the most important item is the 400 tons of drinking water, whose bulk is adequately represented by the circular tank shown in our engraving. This is supplemented by 12,000 quarts of wine and liquors, 15,000 quarts of beer in kegs, besides 3,000 bottles of beer. Last, but not by any means least, is the supply of 40 tons of ice.

Of course, it will be understood that, as in the case of the coal, it is not to be supposed that all of this supply will be consumed on the voyage. There must be a margin, and a fairly liberal margin, of every kind of provision. Moreover, the extent to which the larder and cellar are emptied will vary according to the condition of the voyage. In tempestuous weather, where the trip is a succession of heavy gales, and the dining room tables are liable to be practically deserted for two or three days at a stretch, the consumption will be modified considerably. Stormy voyages of this character, after all, occur at infrequent intervals, and as a rule the supplies are pretty well consumed by the time the passage is over.

Now, having dealt with the general food supplies, we will deal with the food supplies of another large liner for a single trip.

PROVISIONING THE "KRONPRINZ WILHELM" FOR A SINGLE TRANSATLANTIC TRIP.

The Book of Genesis does not record the tonnage of the huge vessel which finally stranded on Mount Ararat, after finishing the most wonderful voyage ever described in the annals of mankind. But it is quite safe to assume that the dimensions of the Ark, that old-time floating storehouse, are exceeded in size by the largest of steamships now crossing the Atlantic.

Not the least striking evidence of the size of these modern monsters of the deep is afforded by the vast quantities of food which must be taken aboard for a single six-day trip across the Atlantic. For the 1,500 passengers and the several hundred men constituting the crew, carloads of food and whole tanks of liquids are necessary. To enumerate in cold type the exact quantities of bread, meat, and vegetables consumed in a weekly trip would give but an inadequate idea of the storing capacity of a modern liner. We have, therefore, prepared a picture which graphically shows by comparison with the average man the equivalent of the meat, poultry, and breadstuffs, as well as the liquors used. Each kind of food has been concentrated into a giant unit, compared with which the figure of the average man seems puny.

On the "Kronprinz Wilhelm," of the North German Lloyd Line, which steamship we have taken for the purpose of instituting our comparisons, some 19,800 pounds of fresh meat and 14,300 pounds of salt beef and mutton, in all 34,100 pounds of meat, are eaten during a single trip from New York to Bremen. This enormous quantity of meat has been pictured in the form of a single joint of beef, which, if it actually existed, would be somewhat less than 10 feet high, 10 feet long, and 5 feet wide. If placed on one end of a scale, it would require about 227 average men in the other end to tip the beam.

For a single voyage the "Kronprinz Wilhelm" uses 2,640 pounds of ham, 1,320 pounds of bacon, and 506 pounds of sausage—in all, 4,466 pounds. Since most of this is pork, it may well be pictured in the form of a ham. That single ham is equivalent in weight to 374 average hams. It is 7¼ feet high, 3 feet in diameter and 2 feet thick.

The poultry eaten by the passengers of the steamer during a trip to Bremen or New York weighs 4,840 pounds. Suppose that we show these 4,840 pounds of poultry in the form of a turkey, dressed and ready for the oven. The bird would be a giant 10 feet long, 8 feet broad, and 5 feet high.

Sauerkraut, beans, peas, rice, and fresh vegetables are consumed to the amount of 25,320 pounds. Packed for market, these preserved and fresh vegetables would be contained in 290 baskets of the usual form, which piled up make a formidable truncated pyramid.

The quantity of eggs required is no less startling than the quantity of vegetables, for some 25,000 are needed to satisfy the wants of passengers and crew. Eggs are usually packed in cases, 30 dozen to the case. The "Kronprinz Wilhelm," when she leaves New York or Bremen, must therefore take on board 69 of these cases, which have been shown in a great pile, 23 cases high and 3 cases wide.

The bakers of the ship find it necessary to use 33,000 pounds of flour during the trip. In other words, 169 barrels are stowed away somewhere in the hold of the big ship.

Besides the foods already enumerated, 1,980 pounds of fresh fish and 330 pounds of salted fish are eaten during the six-day voyage. The total amount of 2,310 pounds would be equivalent to a single bluefish 20 feet long, 5 feet in greatest diameter, and 1½ feet broad. Such a fish compares favorably in length, at least, with a good-sized whale.

The potatoes required far outweigh any other single article of food contained in the storerooms; for their entire weight is 61,600 pounds. If it were possible to grow a single tuber of that weight, it would have a height of 14 feet and a diameter of 7 feet.

The butter, too, if packed into a single tub, would assume large dimensions. This single tub would contain 6,600 pounds, and would be 6 feet high.

Of dried fruit, 2,640 pounds are eaten, and of fresh fruit 11,000 pounds, in all 13,640 pounds. If this fruit were all concentrated into a single pear, its height would be 7 feet, and the width at the thickest part 5 feet.

Whole lakes of liquids are drunk up by the thirsty passengers and crew. No less than 425 tons of fresh water are required, which occupy 14,175 cubic feet and would fill a tank 25 feet in diameter and 30 feet high. The 1,716 gallons of milk used for drinking and cooking would be contained in a can 6 feet 1 inch in diameter and 11½ feet high. The gallons and gallons of wines, liquors, and beer consumed should dishearten the most optimistic temperance advocate. Under the joyous title of "beverages" the following items are to be found in the purser's account book:

Champagne	850 bottles.
Claret	980 bottles.
Madeira, sherry, etc....	135 bottles.
Rhine and Moselle wines.	1,700 bottles.
Rum and cordials.......	760 bottles.
Mineral water..........	5,250 bottles.
Beer in kegs............	2,960 gallons.
Beer in bottles.........	600 bottles.

Suppose these things to drink were contained in one claret bottle. Some idea of the hugeness of this bottle may be gained when it is considered that its height would be over 24 feet and its diameter over 6 feet.

THE ATLANTIC LINERS.

NEW CUNARDERS—PASSENGERS CARRIED—PRICE OF SPEED—ATLANTIC TRUST.

THE NEW CUNARDERS.—The most notable event in shipping circles during 1903 was the government agreement with the Cunard Company, for the building of two vessels of higher speed than any liners in existence. It is an eminently desirable and satisfactory arrangement from the British point of view, and the development of its scientific and technical aspects will be followed with an intensity of interest which can perhaps only be paralleled within living memory by the construction of the "Great Eastern." The reasons for this we shall note directly.

CUNARD AGREEMENT.—Ten years have elapsed since the "Campania" and "Lucania" made the last British record of 22 knots, since which period five German liners have eclipsed the performance of these ships. It is confidently believed that the Cunard Company will be able to exceed the limits imposed by the government terms—of a minimum average ocean speed of 24½ knots an hour in moderate weather. This will be a knot above the "crack" German vessels.

Subject to certain very fair conditions, the government will advance a sum not exceeding $3,000.000 for the building of the two new vessels. This will be secured by a charge upon the whole of the company's assets. It is to be advanced in instalments on the inspector certifying the attainment of certain stages of progress in the work, and the sum will have to be repaid in twenty yearly instalments.

For the mail service the company will receive $340,000 per annum, with extra payment for mails weighing over 100 tons (or 4,000 cubic feet measure-

ment), carried in any one week. The plans for the vessels are not yet made public.

THE FAST BOATS.—That the new departure will pay seems assured, because statistics show that the fastest boats, notwithstanding their higher rates, attract more passengers than the slower boats do. The latter are just as comfortable, and the cuisine is the same, yet a knot or two more in speed doubles and trebles the first-class passengers, to whom in many cases time is money.

Thus, in one week in April, 1903, the "Kaiser Wilhelm II." left New York with 521 first-class, and 355 second-class passengers, while on the same day a vessel of the American Line left with only 82 first-class and 72 second-class passengers. On one day in May the "Kronprinz Wilhelm" left with 380 first and 187 second class passengers, while on the following day a White Star liner took 149 first and 160 second class. Such significant contrasts might be largely multiplied.

"CEDRIC" RECORD.—The big fast ships suffer less from rough weather than the smaller, slower ones, and that apart from speed attracts. The surgeon of the "Cedric," next to the largest liner, reported that on her maiden voyage not a single passenger was seasick. A wine glass, brimming full, was placed on the edge of a sideboard, and left undisturbed throughout the voyage, but not a drop was spilled, nor did the glass move.

THE PRICE OF SPEED.—The increased price that must be paid for speed is a matter that lies in a nutshell. The reason is that a slight advance in speed requires an immense increase in engine power and vast coal storage. These increase the displacement, which again makes still greater demands on the power required. By the time these are provided for, there is no cargo space left worth mentioning. There the limit to size for that speed is reached, and to obtain higher rates involves bigger vessels. This, too, explains why improvements in the design of and economical working of engines and boilers is so eagerly sought after with a view to reduce the cubical space required for these in the hull, and is also one reason why steam turbines are being put on vessels of increasingly large dimensions.

COST IN COAL.—The Admiralty Committee on "Subsidies to Merchant Cruisers" have issued some tabular statements which show the price of speed in a very graphic way. From one of these we see that while a 20-knot steamer consumes 2,228 tons of coal on a 3,000 mile voyage, a 26-knot one will be expected to consume 6,131 tons; and that the 19,000 horsepower of the first must give place to the enormous total of 68,000 horsepower for the last. The cost again of the vessel is $1,750,000 in the slower ship, and $6.250,000 in the swifter. A heavy price truly to pay for the extra six knots! But the investment is a good one on passenger liners, as the previous paragraph shows. The next table shows these and other points in a striking manner:

Speed, in knots	20	21	22	23	24	25	26
Time of voyage (chronometer hours)	150	143	136	130	125	120	115.5
Prime cost, dollars	1,750,000	2,000,000	2,350,000	2,875,000	4,250,000	5,000,000	6,250,000
Indicated horsepower	19,000	22,000	25,500	30,000	40,000	52,000	68,000
Length, in feet	600	630	660	690	720	750	780
Displacement tonnage	13,000	15,000	17,300	19,800	22,400	25,400	28,500
Coal, in tons	2,228	2,456	2,912	3,058	3,900	4,876	6,131
Steam pressure, pounds per square inch	150	165	181	198	216	234	254
Machinery department, number of hands	100	110	125	150	200	260	340

The following table compiled from Lloyd's gives the number of vessels built in Great Britain, arranged according to size. They vary somewhat from the returns quoted on other pages.

Vessels.	Under 200 Tons.	200 to 399 Tons.	400 to 599 Tons.	600 to 799 Tons.	800 to 999 Tons.	1,000 to 1,499 Tons.	1,500 to 1,999 Tons.	2,000 to 2,999 Tons.	3,000 to 3,999 Tons.	4,000 to 4,999 Tons.	5,000 to 6,999 Tons.	7,000 to 9,999 Tons.	10,000 Tons and above.	Grand Total. No.	Grand Total. Tonn'ge.
Sail	4	—	—	—	—	—	6	6	3	—	—	—	—	19	36,384
Steam	77	69	25	15	10	34	36	53	89	60	41	19	9	537	1,376,327
Total	81	69	25	15	10	34	42	59	92	60	41	19	9	556	1,412,711

STEAM TURBINES AND SPEED.

GROWTH OF THE STEAM TURBINE.—The steam turbine has been applied to the propulsion of vessels, and is steadily growing in favor.

The number of vessels so fitted is not large, but the development is none the less remarkable when we remember that pleasure, and cross-channel steamers, torpedo-boat destroyers, and yachts are now fitted with these engines, while ten years ago not one turbine vessel was in service.

EARLY TYPES.—The "Turbinia," 1894, was the first of the kind, followed by the "Viper," 1898, and the "Cobra." The "King Edward," 1901, was the first passenger steamer so fitted, followed by the "Queen Alexandra," 1902, both for passenger service on the Clyde.

CROSS-CHANNEL BOATS.—The success of these vessels was the immediate cause of the application of the steam turbine to the cross-channel services—the "Queen" for the Dover-Calais route, and the "Brighton," the Newhaven-Dieppe boat. On an unofficial trip made in August, 1903, this vessel maintained a speed of 20 knots. The "Brighton" is 282 feet in length, and accommodates 1,000 passengers. Her engines are rated at 7,000 horsepower. The reversing turbines are fitted to the outside screw shafts, and are capable of moving her astern at about 12 knots. The lubrication of the engines is automatic, the oil being supplied at a pressure of 6 lbs. per square inch. The "Queen" has also behaved excellently, running between Dover and Calais within the hour, in a gale of wind.

IRISH BOATS.—Two steam turbine vessels are being built for the Midland Railway service between England, the Isle of Man, and Belfast. Two others of the same class will be fitted with ordinary reciprocating engines, so that relative tests of the two kinds of propulsion will be available under equal conditions. The steamers will be of 20 knots speed, 330 feet long, by 40 feet beam, and 25 feet depth.

THREE YACHTS have been fitted with steam turbines. Two torpedo-boat destroyers, the "Velox" and the "Eden," and the "Amethyst," third-class cruiser, are designed for turbine propulsion. the first being in commission, the others at the time of writing being on order.

A COMMISSION has been appointed, at the suggestion of Lord Inverclyde, to investigate the question of the economy of steam turbines and their suitability to the new big Cunarders. The commission comprises representatives of the Admiralty, the Cunard Company, Lloyd's, and three shipbuilders. At the time of writing no decision has been published. But the fact of such a commission having been appointed testifies to the rapid headway which the turbine is making. But two or three years since, most shipbuilders would have declined even to seriously entertain or to discuss such a proposal. The Allan Line and the Union Steamship Co. are building a 17 and an 18-knot turbine vessel respectively.

OBJECTIONS.—Though the above is not a large list, it must be remembered that shipowners and the Admiralty are naturally very cautious in fitting vessels with novel means of propulsion. The whole history of steam navigation is one of slow but sure advances. The installation of water-tube boilers is another case in point.

The great objection to the use of turbines for driving ocean liners is that this form of engine does not reverse. A separate set of engines is employed for reversing, at lower speeds. The captains of big vessels strongly object to this, because they say that even greater power would be desirable for going astern than ahead, in order to avoid sudden collision.

LAND TURBINES.—On land, Parsons' turbines are being used extensively for driving electric generators, aggregating about 250,000 horsepower, and in sizes up to 5,000 horsepower. Yet the first practical steam turbine was not built until 1884, and that is now in the South Kensington Museum. A recent computation gives the total aggregate power of steam turbines of all types in use, under construction, or ordered, in different parts of the world, at over 500,000 horsepower.

ADVANTAGES OF TURBINES.—The principal point in favor of a turbine is, that it has no reciprocating motion, like that of the piston of a common engine, and therefore the hull of a vessel is not shaken so much as by reciprocating engines. Turbine en-

gines weigh much less, and occupy less room than ordinary engines of the same power, so that passenger accommodation can be increased. Usually three sets of engines are employed, each driving a separate propeller shaft, which again conduces to steadiness of motion.

EXPIRATION OF PARSONS' PATENT.—Several circumstances have occurred latterly to help on the progress of the steam turbine besides its recent successful application to steam yachts, Clyde pleasure steamers, and cross-channel services. One of these is the expiration during the year 1903 of the five years' extension of the patent that was granted to the Hon. C. A. Parsons in 1884. A result of this is that several firms now express their intention of going in for the manufacture of Parsons' turbines. Another is that the success of these turbines has acted as a stimulus to other inventors, and the Parsons turbine will have to face the rivalry of others, including the De Laval, and another promising one, that of Mr. C. G. Curtis, of New York.

It is safe to predict that the old-fashioned steam engines, the big mill type excepted, will gradually give place to the steam turbines, and to the gas and oil engines. Apart from economy and compactness, the turbines are cleaner than any other engines, being self-lubricating and enclosed.

—*Daily Mail Year Book*, 1904.

UNITED STATES LIFE-SAVING SERVICE.

The number of disasters to documented vessels within the scope of the Service was 346 for the fiscal year ending June 30, 1903. On board these vessels were 3,682 persons, of whom 20 were lost. The estimated value of the vessels was $7,101,605 and that of their cargoes $1,746,610, making the total value of property involved $8,848,215. Of this amount $7,683,580 was saved and $1,164,635 lost. The number of vessels totally lost was 57. In addition to the foregoing there were 351 casualties to undocumented craft—sailboats, rowboats, etc.—carrying 655 persons, 4 of whom perished. The value of property involved in these instances is estimated at $202,935, of which $198,465 was saved and $4,470 lost.

The results of disasters to vessels of all descriptions within the scope of the Service, therefore, aggregate as follows:

Total number of disasters	697
Total value of property involved	$9,051,150
Total value of property saved	* $7,882,045
Total value of property lost	$1,169,105
Total number of persons involved	4,337
Total number of persons lost	24
Total number of shipwrecked persons succored at stations	* 1,086
Total number of days' succor afforded	* 2,414
Number of vessels totally lost	57

The foregoing summary does not include 56 persons not on board of vessels who were rescued from various positions of peril.

VESSELS ASSISTED.

The life-saving crews saved and assisted in saving 438 imperiled vessels, valued with their cargoes at $4,598,840. Of this number 287, valued with their cargoes at $793,670, were saved without other assistance. In the remaining instances, 151 in number, the life-saving crews co-operated with wrecking vessels, tugs, and other agencies in saving property estimated at $3,661,875, out of a total of $3,805,170 imperiled. Besides this the crews afforded assistance of greater or less importance to 573 other vessels, rendering aid, therefore, altogether to 1,011 vessels of all kinds, including small craft. This number is exclusive of 218 instances in which vessels running into danger were warned off by station patrolmen. One hundred and ninety-eight of these warnings were given at night by Coston lights.

The apportionment of the foregoing statistics to the Atlantic, Lake and Pacific coasts, respectively, is shown in the following table:

* It should not be understood that the entire amount represented by these figures was saved by the Service. A considerable portion was saved by salvage companies, wrecking tugs, and other instrumentalities, often working in conjunction with the surfmen. It is manifestly impossible to apportion the relative results accomplished. It is equally impossible to give even an approximate estimate of the number of lives saved by the station crews. It would be preposterous to assume that all those on board vessels suffering disaster who escape would have been lost but for the aid of the life-savers; yet the number of persons taken ashore by the lifeboats and other appliances by no means indicates the sum total saved by the Service.

APPORTIONMENT TO ATLANTIC, LAKE AND PACIFIC COASTS.

Disasters to Vessels.	Atlantic and Gulf coasts.	Lake coasts.*	Pacific coast.	Total.
Total number of disasters	438	226	33	697
Total value of vessels.......dollars	3,501,520	2,888,860	910,575	7,300,955
Total value of cargoes.......do	973,370	720,025	56,800	1,750,195
Total amount of property involved...do	4,474,890	3,608,885	967,375	9,051,150
Total amount of property saved.....do	3,636,745	3,360,145	885,155	7,882,045
Total amount of property lost......do	838,145	248,740	82,220	1,169,105
Total number of persons on board	2,694	1,177	466	4,337
Total number of persons lost	20	3	1	24
Number of shipwrecked persons succored at stations	†970	†102	†14	†1,086
Total number of days' succor afforded	†2,238	†162	†14	†2,414
Number of disasters involving total loss of vessels	46	10	1	57

GENERAL SUMMARY

Of disasters which have occurred within the scope of life-saving operations from November 1, 1871 (date of introduction of present system), to close of fiscal year ending June 30, 1903.‡

Total number of disasters	14,076
Total value of vessels	$148,098,035
Total value of cargoes	$62,253,644
Total value of property involved	$210,351,679
Total value of property saved	$166,253,022
Total value of property lost	$44,098,657
Total number of persons involved	§102,474
Total number of lives lost	‖ 1,027
Total number of persons succored at stations	¶ 17,747
Total number of days' succor afforded	43,006

The Board on Life Saving Appliances was constituted by the Secretary of the Treasury, January 3, 1882, and meets periodically for the transaction of such business as may come before it. Inventors and exhibitors are allowed to appear before the court to explain the methods of construction and set forth the merits claimed for their devices. Committees are then appointed to consider the various devices submitted to the Board, and each committee reports upon each device, and the results are published in the Report of the Board on Life Saving Appliances, which is incorporated in the Annual Report of the United States Life Saving Service.

THE LIGHTHOUSE ESTABLISHMENT.

There are under the control of the Lighthouse Establishment, Oct. 15, 1903, the following named aids to navigation:

Light-houses and beacon lights	1,425
Light-vessels in position	45
Light-vessels for relief	8
Gas-lighted buoys in position	119
Fog-signals operated by steam, caloric, or oil engines, about	200
Fog-signals operated by machinery, about	250
Post lights, about	1,875
Day or unlighted beacons, about	550
Whistling buoys in position, about	90
Bell buoys in position, about	130
Other buoys in position, including pile buoys and stakes in Fifth district and buoys in Alaskan waters	5,500

In the construction, care and maintenance of these aids to navigation there are employed:

Steam tenders	39
Steam launches	7
Sailing tenders	2
Light-keepers, about	1,550
Officers and crews of light-vessels and tenders, about	1,225
Laborers in charge of post lights, about	1,600

* Including the river station at Louisville, Kentucky.

† These figures include persons to whom succor was given who were not on board vessels embraced in table of casualties.

‡ It should be observed that the operations of the Service during this period have been limited as follows: Season of 1871-72, to the coasts of Long Island and New Jersey; seasons of 1872-74 to the coasts of Cape Cod, Long Island, and New Jersey; season of 1874-75, to the coasts of New England, Long Island, New Jersey, and the coast from Cape Henry to Cape Hatteras; season of 1875-76, to the coasts of New England, Long Island, New Jersey, the coast from Cape Henlopen to Cape Charles, and the coast from Cape Henry to Cape Hatteras; season of 1876-77 and since, all the foregoing with the addition of the eastern coast of Florida and portions of the lake coasts. In 1877-78 the Pacific coast was added, and in 1880 the coast of Texas.

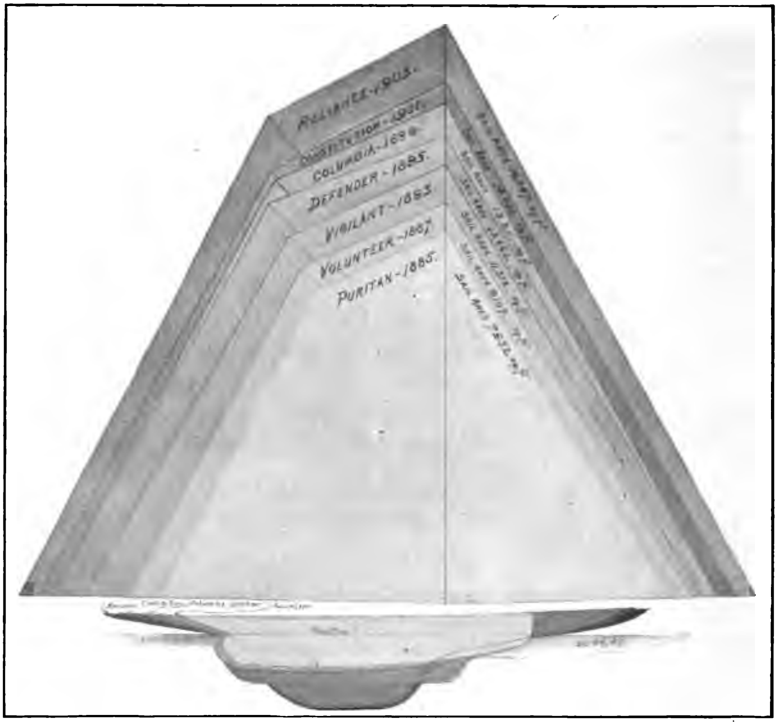
§ Including persons rescued not on board vessels.

‖ Eighty-five of these were lost at the disaster to the steamer *Metropolis* in 1877-78, when service was impeded by distance, and 14 others in the same year owing to similar causes.

¶ Including castaways not on board vessels embraced in Tables of Casualties.

FROM CRUISER TO RACING MACHINE.

What might be called the scientific period of yacht designing in this country begins at about the period of the races of "Puritan" against "Genesta," in 1885. The growth to the exaggerated proportions of hull and sail plan shown in our accompanying diagram, is the logical and inevitable outcome of a rule of measurement altogether too broad and loose in its specifications. The only elements taxed in this rule are length on the water-line when on an even keel, and total sail area. To the competing designers the rule has said, "When your yachts are placed under the measurer's tape, if 90-footers they must not be over 90 feet long on the water-line, or if 70-footers not over 70 feet. If you choose to make them a little less than these lengths, their rating will be diminished accordingly. Outside of this restriction you may do just anything you please in modeling your hulls. They may be built of any material; they may be broad or narrow, shallow or deep; light and leakable as a wicker basket, or tight and heavy as an ironclad. As to the spread of sail, you may crack on just as much as you please; always with the understanding, however, that the more you carry the greater will be your racing measurement."



GROWTH OF THE AMERICAN CUP DEFENDER FROM CRUISER TO RACING MACHINE.

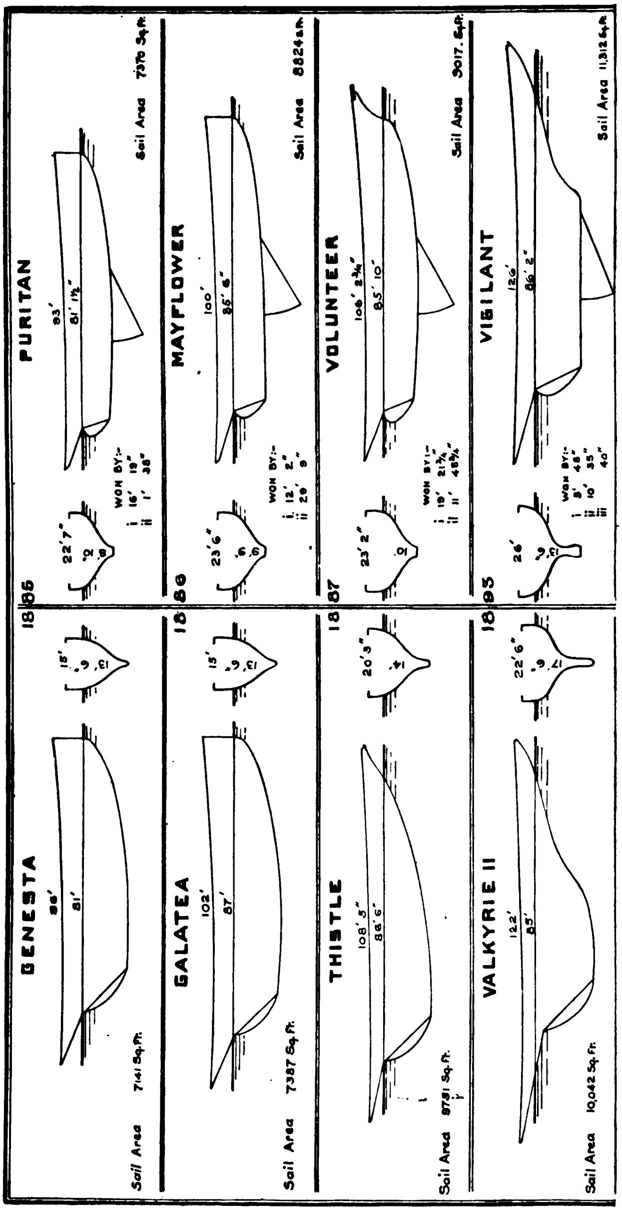
Now at the time of the "Puritan"-"Genesta" races, our yacht designers were beginning to emerge from the rule-of-thumb methods that characterized the days of the center-board sloop

and schooner, and were beginning, thanks to the victorious career of one or two imported deep-keel English cutters, to appreciate the value of outside lead as an element of sail-carrying power. Hence, the "Puritan" carried a large proportion of her 48 tons of lead ballast on the keel, and although she was marked by the shoalness of body and limited draft of the prevailing centerboard type, she was an extremely able sea boat, fast and comfortable, a wooden vessel of first-class construction, with a reasonable spread of sail which she was well able to carry in a blow, as was proved in that memorable race of twenty miles to leeward and back in half a gale of wind in which she won by a narrow margin over "Genesta." At the close of her racing career "Puritan" was changed from sloop to schooner rig, and to-day she is doing service as a snug and comfortable cruiser. "Mayflower," the next cup defender, was an improved "Puritan," with 5 feet more length on the water-line and 8,824 square feet of sail; she was built of wood, and subsequently to her defense of the cup she was turned into a comfortable cruiser. Her sail area is so nearly the same as that of her successor, "Volunteer," that to avoid crowding our drawing her sail-plan does not appear. "Volunteer" was designed by Burgess, the designer of "Puritan" and "Mayflower." She was the first of our large sloops to be built of steel. She was about 5 feet longer on the water-line than "Puritan" and carried a much larger sail-plan, the boom being 84 feet as against 76 1-2 feet of "Puritan," and the hoist to the topmast sheave being 111 feet as against 104 feet in the earlier boat. "Volunteer" also was a perfectly sound and wholesome vessel. Although her rig was a large one, she was well able to carry it; and like her predecessor she was changed after the cup races to a schooner, and is to-day in service as a successful cruiser. After a lapse of six years the New York Yacht Club was called upon once more to defend the cup, and on this occasion they went to Herreshoff, from whom they obtained two yachts, one of which, the "Colonia," was a keel boat, drawing 14 feet of water, built of steel, and carrying about 11,000 square feet of sail. She was a failure, for the reason that, like the "Navaho," another Herreshoff 90-footer of the same year, she was a poor boat on the wind.

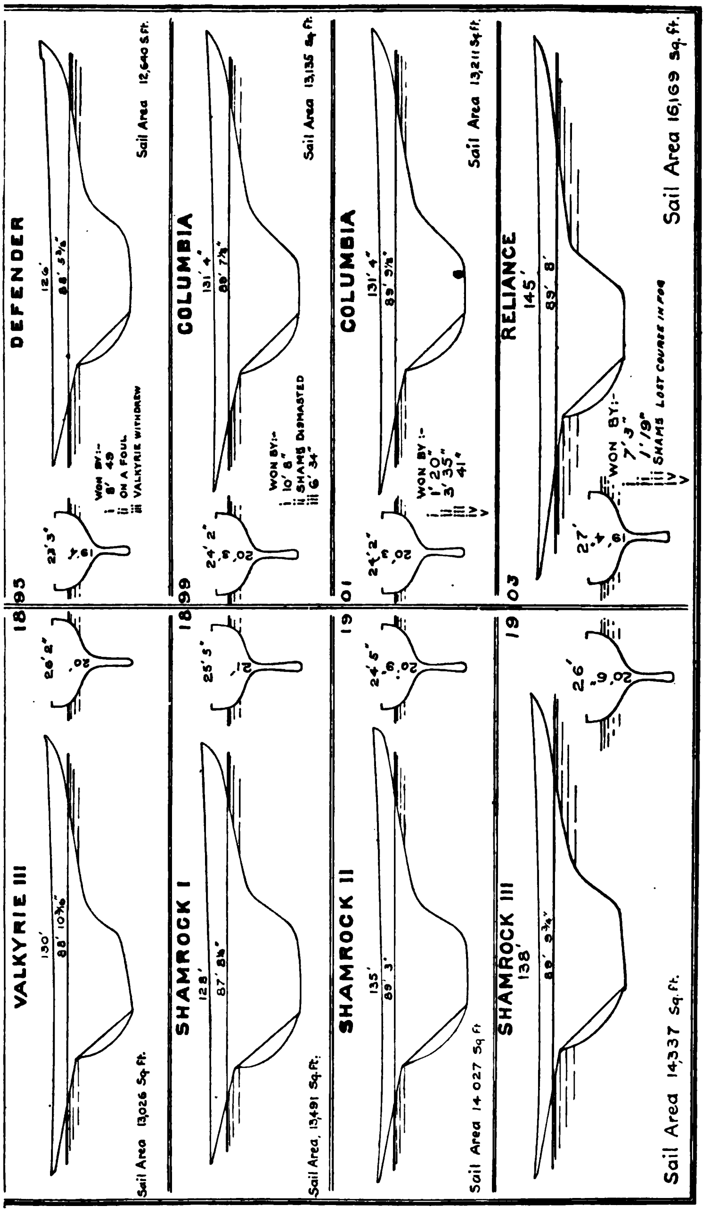
The other yacht built for cup defense by Herreshoff was the "Vigilant," and in her we see the engineer attacking the problem of yacht design from his own particular point of view. Tobin bronze is used for the plating, hollow spars are experimented with, and high-grade steel wire rope, blocks and other gear of extreme lightness, make their appearance in the spar and sail-plans. As a consequence, although the "Vigilant" was only a few inches longer on the water-line than the "Volunteer," she carried over 2,000 square feet more sail. The boom was lengthened out to nigh upon 100 feet, while the hoist went up to 132 feet; and the sail spread to 11,312 square feet. "Vigilant" was to be the last of the centerboard yachts; for although she beat "Valkyrie II." in the series of races, she was beaten badly to windward by that boat in a stiff breeze; and subsequently, during a season in English waters, was beaten eleven times out of eighteen by the deep-keel cutter "Britannia," a sister boat to "Valkyrie II." That season's experience sealed the fate of the centerboard. and when the next challenge came, the Herreshoffs, entrusted with the contract of

THE DEVELOPMENT OF THE 90-FOOT RACING YACHT.

Yachts.	Water-line Length.		Base of Fore Triangle.		Hoist from Boom to Topmast Sheave.		Boom.		Gaff.		Spinnaker Boom.		Total Sail Area.
	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	ft.	in.	sq. ft.
Puritan	81	1½	62	0	104	0	76	6	47	0	62	0	7,370
Mayflower	85	7	67	0	111	0	80	0	50	0	67	0	8,824
Volunteer	85	10	67	0	111	0	84	0	51	6	67	0	9,107
Vigilant	86	2	69	0	122	0	98	0	57	0	69	0	11,312
Defender	88	5⅛	73	3	129	5	106	0	64	10	73	4	12,640
Columbia	89	7⅛	73	3	138	5	107	0	64	10	73	4	13,211
Constitution	89	9	78	0	142	0	110	0	72	0	78	0	14,400
Reliance	90	0	84	0	155	0	115	0	72	0	84	0	16,247



DEVELOPMENT OF THE INTERNATIONAL



RACING YACHT FROM 1885 TO 1903.

building a yacht to beat her, turned out to meet her the deep-keel cutter-sloop "Defender." "Vigilant" was the last of the cup-defenders that was good for anything but cup defense. She has been changed into a yawl, and has proved to be an excellent cruiser under her reduced rig. In "Defender" we see the engineer still at work, reducing scantling and lightening up on construction even to the smallest detail. "Defender" was built of manganese bronze in the underbody, and aluminium in the topsides and framing. She carried a hollow steel mast, boom and gaff. As a consequence, although she was a smaller boat than "Vigilant," having some 3 feet less beam, so great was the lightening of her weights, and the increase in stability due to lower ballast, that she carried over 1,000 feet more sail than the larger yacht, spreading 12,640 square feet. The main boom reached far over the taffrail, being 106 feet in length over all. The hoist was 7 1-2 feet greater and the forward measurement from mast to end of bowsprit had increased to over 73 feet.

When the "Defender" commenced her trials it began to be evident that in the development of the 90-foot racing yacht the limit, not merely of convenience but of actual safety, had been passed. The draft of 19 feet was in itself prohibitive of the use of the boat as a cruiser, since it shut her out from many of the harbors and desirable anchorages, while the experience of the boat in fresh to moderate breezes was marked by breakdowns which, on one occasion, came very near to being disastrous. In some races, when the wind breezed up, rivets were sheared off and the climax came when in a bit of a squall the pull of the weather shrouds was so great that the mast came very near punching a hole for itself through the bottom of the boat. Herreshoff evidently had overlooked the fact that, in cutting into the keel until its forward edge was aft of the mast-step, he had left nothing but the light floor-plates and the frail plating to take the enormous downward thrust of the mast. Emergency repairs were at once made by carrying a pair of ½-inch by 8-inch steel straps from the toot of the mast up to a junction with the chain-plates at the deck. Trouble was also experienced in keeping the bowsprit from coming inboard; several of the frames of the boat broke at the turn of the garboards; and from first to last the extreme lightness of the craft was a source of unceasing anxiety to her owners.

Four years later the Bristol yard turned out "Columbia," a yacht that embodied some of those features of hull and sail-plan which experience in the smaller classes had shown to be conducive to high speed. She had a foot more depth, or 20 feet; her overhangs, forward and aft, were carried out until on a water-line length of 89 feet 7 1-8 inches she had an over-all length of about 50 per cent more, or 132 feet. Although a 90-footer when at anchor she was a 115-footer when heeled to her sailing lines, the great increase in the overhangs being due to the effort to build the biggest possible boat on the arbitrary so-called 90-foot length. The enlargement of the sail-plan was chiefly in the direction of greater hoist, the distance from main boom to topmast sheave being 138 1-2 feet. The disastrous experience with "Defender" showed the absolute necessity of using more reliable materials in the hull, which was constructed of Tobin bronze plating on steel frames. The hull structure proved satisfactory, but the lightening up of the spars and standing rigging had been carried too far, as shown by the fact that in her trial races she carried away her mast.

Two years later, to meet "Shamrock II.," Herreshoff brought out the "Constitution," which differed in form from "Columbia" merely by an increase of one foot in the beam. The sail-plan was greater than that of "Columbia" by about 1,200 square feet. The hoist had now increased to 142 feet, the boom to 110 feet, and the base of the forward triangle to 78 feet. "Constitution's" appearance is comparable only to that of "Defender" in the constant succession of breakdowns that have occurred; but with this distinction, however, that whereas "Defender's" trouble was in the hull, "Constitution's" has been up aloft. At different times she has carried away her mainmast, her topmast and her gaff. Of the hull, however, it must be admitted that the system of belt-and-longitudinal framing adopted by Herreshoff has been eminently successful. Although it is probable that no large amount of weight is saved over the old system of framing, it is certain that weight for weight it is considerably stronger. "Constitution" proved so much of a disappointment that it was really realized that to defend the cup successfully some radical depar-

ture must be taken, and Herreshoff struck out most boldly in the direction of the "scow" type, which had proved so fast in the smaller classes of yachts. On a water-line of 90 feet the new boat has a beam of over 26 feet, a draft of 20 feet, and an over-all length of close upon 150 feet. Although she is a 90-footer at anchor, she is fully a 120-footer when heeled to a breeze; and to this fact is to be ascribed the astonishing sail-carrying power which she has shown, the area under the New York Yacht Club measurement being 16,247 square feet; and if changes are made they will be rather in the direction of an increase than a reduction of sail-plan. The growth of sail power in the last fifteen years may be summed up in the statement that on an increased water-line length of only 10 feet the "Reliance" of 1903 spreads over twice as much sail as did "Puritan" in 1885. In her we see, unquestionably, the highest possible development under the existing rule, and although the boat is an overgrown monstrosity as a sailing craft, she is certainly a great tribute to her builder, both as a naval architect and as a wonderfully resourceful and ingenious mechanic. She is the biggest, lightest constructed, most powerful, and probably the fastest yacht of her water-line length that ever was or ever will be constructed, and she possesses that dual quality, never before found in one and the same yacht, of being relatively just as fast in light as she is in strong winds.

CHAPTER III.

THE NAVIES OF THE WORLD.

The subject of the navies of the world is a most important one. Schemes of classification vary, and it is difficult to obtain any figures which agree. The three English authorities are "The Naval Annual," by T. A. Brassey; "The Naval Pocket Book," by Sir W. Laird Clowes, and F. T. Jane's "All the World's Fighting Ships" (Munn & Co., publishers). The latter is filled with illustrations, diagrams, etc., and has an excellent thumb index, facilitating easy reference. Our comparison of naval strength is based on these three books. In addition, we give the tables of the Hydrographic Office, and for those who care to pursue the matter further, we give an abstract of the section of Hazell's Annual dealing with the subject. With this explanation it is hoped that the dissimilar figures will not be as confusing as they otherwise would be.

THE CONSTRUCTION AND CLASSIFICATION OF MODERN WARSHIPS.

The modern warship is an ever popular subject with the readers of the illustrated press. This is proved by the tenacity with which guns, ships and armor hold their place as conspicuous subjects for the pen and the brush. It is a question, however, in spite of the familiarity of the public with the technical phraseology of the warship, whether the average reader has a very accurate idea of the distinctions between the various classes of ships and between the various elements from the combination of which these ships derive their distinctive class characteristics. He is told that the "Indiana" is a battleship, the "Brooklyn" an armored cruiser, the "Columbia" a protected cruiser, and the "Puritan" a monitor. But it is probable that he has only a vague idea as to what qualities they are that mark the distinction, or why the distinctions should need to exist at all.

With a view to answering these questions in a general way, we have prepared three diagrams and a perspective drawing which show the constructive features of the several types of warship to which we have referred above. In diagrams I to III the armor is indicated by full black lines or by shading, the approximate thickness of the armor being shown by the thickness of the lines and the depth of the shading. The fine lines represent the unarmored portions of the ordinary plating of the ships. In the end view the armor is shown by full lines and shading and the ordinary ship plating by dotted lines.

When the naval architect sits down at his desk to design a warship of a certain size, he knows that there is one element of the vessel which is fixed and unalterable, and that is her displacement. By displacement is meant the actual weight of the ship, which is, of course, exactly equal to the weight of water which she displaces. This total weight is the capital with which the architect has to work, and he uses his judgment in distributing it among the various elements which go to make up the ship. Part is allotted to the hull, part to the motive power, part to the armor protection, part to the guns, and part to the fuel, stores, furnishing and general equipment.

It is evident that the allotment of weights is a matter of compromise—whatever excess is given to one element must be taken from another; else, the ship will exceed the given displacement. Among the elements above mentioned there are some, such as weight of hull, provisions, stores, and furnishings, which for a given size of ship will not vary greatly.

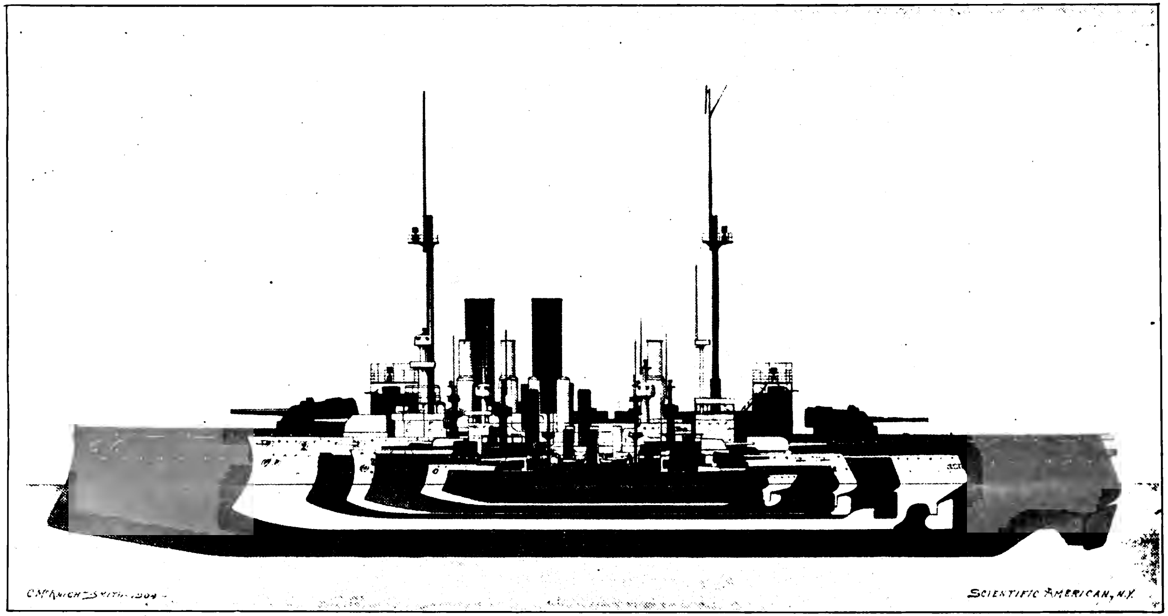


DIAGRAM SHOWING, BY SIDE ELEVATION OF TYPICAL BATTLESHIPS, THE RELATIVE STRENGTH OF THE NAVIES OF THE WORLD, BUILT AND UNDER CONSTRUCTION, JANUARY 1, 1904.

Order of size: 1 England; 2 France; 3 United States; 4 Germany; 5 Russia; 6 Italy; 7 Japan.

ENGLAND,	FRANCE,	UNITED STATES,	GERMANY,	RUSSIA,	ITALY,	JAPAN,
1,867,250 tons.	755,757 tons.	616,275 tons	505,619 tons.	458,432 tons.	329,257 tons.	253,681 tons.

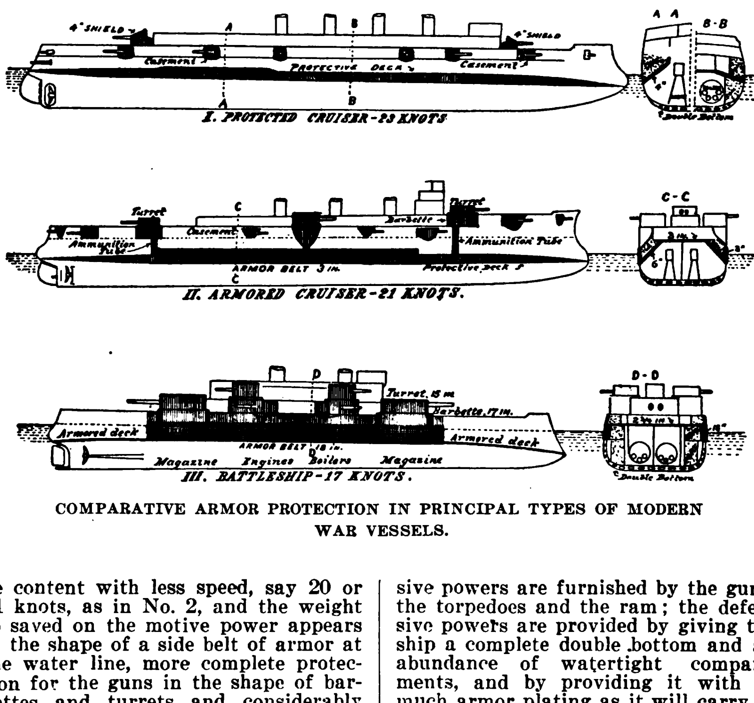
Relative size of navies shown, if all ships now under construction January 1, 1904, were completed.

NAVIES OF THE WORLD COMPARED.

There are other elements, such as guns, armor, engines and fuel-supply, which may vary considerably in different ships, according to the type of vessel that is produced. If, for instance, the architect is designing an extremely fast ship of type No. 1, which has a speed of 23 knots, he will have to allot such a large amount of weight to the motive power that he will only be able to give the ship very slight armor protection and a comparatively light battery of guns. If he wishes to produce a fast ship that shall be more heavily armed and armored, he has to besides protecting his water line in the region of the engines and boilers with a belt of steel of the same dimensions.

The swift and lightly armed and armored ship is known as a protected cruiser; the less speedy but more heavily armed and armored ship belongs to the armored cruiser type, and the slowest ship, with its capacity for taking and giving the heaviest blows that modern guns can inflict, is known as a battleship.

In the construction of a warship the two qualities of attack and defense have to be supplied. The offen-



COMPARATIVE ARMOR PROTECTION IN PRINCIPAL TYPES OF MODERN WAR VESSELS.

be content with less speed, say 20 or 21 knots, as in No. 2, and the weight so saved on the motive power appears in the shape of a side belt of armor at the water line, more complete protection for the guns in the shape of barbettes and turrets and considerably heavier armament. If, again, he desires to produce a ship capable of contending with the most powerful ships in line of battle, as in No. 3, he is content with much lower speed, say 16 or 17 knots an hour, and he increases the power of his guns until they weigh over 60 tons apiece, and protects them with great redoubts and turrets of steel 1 1-2 feet thick, sive powers are furnished by the guns, the torpedoes and the ram; the defensive powers are provided by giving the ship a complete double bottom and an abundance of watertight compartments, and by providing it with as much armor plating as it will carry to keep out the shells of the enemy. The greatest danger to which a warship is exposed is that of being sunk either by under-water attack by torpedoes or the ram, or by being penetrated at the water line by heavy shell fire. The destructive force of a torpedo is so great that all that can be done is to localize its effects. For this purpose, and also to give greater structural

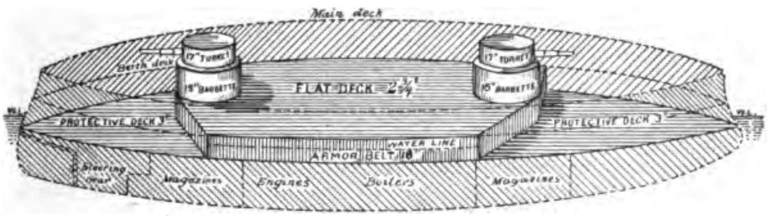
strength, the hull below the water line is built double—a hull within a hull. The longitudinal and transverse plate framing of the ship is built in between these shells, which are known as the inner and outer bottoms, and the space is thus divided into innumerable watertight compartments or cells. There is a possibility that a blow that would burst in the outer shell might not rupture the inner shell; but if it should, the inflow of water is confined to a limited portion of the hull by dividing the latter by transverse and longitudinal walls or bulkheads of plating. A blow that burst in both outer and inner shells would only admit water to one of many compartments, and the ship would still have a large reserve of buoyancy.

In protecting warships against shell fire it is recognized that there are certain parts of the ship which are of paramount importance, inasmuch as their disablement would leave it at the mercy of the enemy. These are the "vitals" of the ship, and they comprise the magazines, the boilers, the engines and the steering gear. If a shell penetrated the magazines, it would be liable to result in the blowing up of the whole ship, and if it entered the boiler, engine or steering rooms, it would probably render the ship unmanageable, in which event she would run the risk of being rammed and sunk by the enemy.

In all warships the vitals are covered by a complete protective deck of steel, which varies in thickness from 1 1-2 to 3 inches. The highest part of the deck is generally at a slightly higher level than the water line amidships, and it curves down at each end to meet the bow and the stern. In the battleship this deck is generally flat from side to side amidships for about two-thirds of the ship's length. At the sides it rests upon a wall of vertical armor from 15 to 18 inches in thickness, which extends in the wake of the magazines, engines and boilers. This side armor is usually about 7 1-2 feet in height, 3 feet of it being above and 4 1-2 feet below the water line. At each end of the side armor a transverse wall of armor extends clear across the ship. This rectangular wall with its roof of 3-in. steel thus forms a kind of inverted box, snugly sheltered below which are the before mentioned "vitals" of the ship. At each end of this inverted box two huge barbettes, with walls 15 to 17 inches thick, are built up to a few feet above the main deck, and just within and above them revolve a pair of turrets with walls of 15 to 17 inch steel. (See perspective view.) The turrets give shelter to the big guns, of which there are a pair in each, and the barbettes protect the turning gear by which the turrets are rotated. There is thus a continuous wall of 15 to 17 inch steel extending from 4 feet below the water line to the roofs of the turrets.

With this description in mind the reader will see, on looking at diagram No. III., that before heavy shells can injure the engines, boilers or guns, they must pass through from 15 to 18 inches of solid and, in the case of American battleships, face-hardened Harvey steel. The 6-inch and 8-inch guns are protected by 6 and 8 inches of steel.

Now it can readily be understood that all this amount of heavy armor and guns adds greatly to the weight of the ship, and for this reason, in



(All parts above the water lines shown by dotted lines and light shading, might be shot away without destroying the fighting power of the ship.)

THE INVULNERABLE, FLOATING FORT, WITHIN THE OUTER WALLS OF A MODERN BATTLESHIP.

spite of her smaller engine power, a firstclass battleship rarely displaces less than 10,000 tons, and in some foreign navies the displacement runs up to nearly 16,000 tons. This will be understood by reference to the perspective view, where the armored portions of the ship are indicated by full lines and shading. It will be seen that all that part of the ship lying below the water line is shut in by a continuous roof of steel which is 3 inches in thickness forward and aft of the bulkheads. Over the central armored citadel it is 2 3-4 inches thick. All the plating indicated by dotted lines might be shot away without the "vitals" suffering injury or the ship being sunk. The reader will see that it is the battleship's sides and the extra deck and freeboard which they provide which constitute practically the difference between a battleship and a monitor.

This brings us to the consideration of the monitor type. Take away from a battleship all that portion which is shown in our drawing in shaded lines above the water line; lower the barbettes until they rise only a few feet above the steel deck, and we have a ship of the general monitor type. The monitor is distinguished by very low freeboard—only a few inches in the extreme type—the absence of a heavy secondary battery and the possession of a main armament of heavy guns. Such a ship labors heavily in bad weather and is not intended for service at any distance from the coasts. To make a seagoing vessel out of her it would be necessary to add one, or even two decks, placing the guns well up above the water, after which changes she would be no longer a monitor, but a seagoing battleship.

In the cruiser type the protective deck does not extend across the ship at one level, but curves down to meet the hull at a point several feet below the water line. This sloping portion is made thicker than the flat portion, as in diagram No. II., where the deck is 3 inches thick on the flat and 6 inches on the slopes. In the case of the armored cruisers, a belt of vertical armor is carried at the water line and in all cruisers the V-shaped space between belt and sloping deck is filled in with coal or with some form of water-excluding material, such as cornpith cellulose. In diagram II., which represents the fine armored cruiser "Brooklyn," it will be seen that before it could reach the engine room a shell would have to pass through 3 inches of vertical steel, about 6 feet of coal and 6 inches of inclined armor—a total resistance equal to 14 or 15 inches of solid steel. The guns and turning gear are protected by 5 1-2-inch steel turrets and 8-inch barbettes. The barbettes, it will be seen, do not extend continuously down to the armored deck, as in the battleship, for this would require a greater weight of armor than can be allowed. Consequently, the architect is only able to furnish the guns with a small armorplated tube for protecting the ammunition in its passage from the magazines to the barbettes.

In the protected cruiser the side armor at the water line disappears altogether, and dependence is placed entirely upon the sloping sides of the protective deck, the water-excluding cellulose and the 6 or 8 feet of coal which is stowed in the bunkers in the wake of the engines and boilers. The barbettes, turrets and armored ammunition tubes of the armored cruiser disappear, and their place is taken by comparatively light shields and casements of 4-inch steel which serve to protect the gun crews.

It will be seen from the above description that each class of vessel is only fitted to engage ships of its own type. The protected cruiser "Columbia" (No. I.) might, with her light 6 and 4 inch guns, hammer away all day at the "Indiana" (No. III.) without being able to do much more than knock the paint off the latter's 18-inch armor, whereas one well-directed shot from the 13-inch guns of the "Indiana" would be sufficient to sink or disable the "Columbia." The "Brooklyn" would fare better, and at close range her 8-inch guns might happen to penetrate the belt or turret armor of the "Indiana," but the issue of the duel would never be in doubt for an instant. A "Columbia" or a "Brooklyn" would show its heels to an "Indiana" or "Massachusetts," and their great speed would give them the option of refusing or accepting battle with almost any craft that is afloat upon the seas to-day.

It should be mentioned, in conclusion, that the dividing lines in the classification of warships are somewhat flexible.

RELATIVE STRENGTH IN MATERIEL: PRINCIPAL NAVIES.

A Parliamentary Return dated March 26th, 1903, was issued in May of that year, showing the Fleets of Great Britain, France, Russia, Germany, Italy, the United States of America, and Japan. This return is here brought up to date Dec. 31st, 1903. This refers to the text matter.—*Hazell's Annual.*

The figures in the tables show the condition of affairs on Jan. 1, 1904; since this time the Russo-Japanese war shows great changes. The severe losses of the Russians and the slight losses of the Japanese have been taken into account in the tables. The third, fourth and fifth tables are issued by the Office of Naval Intelligence, U. S. N., with modifications, according to newspaper reports, occasioned by the Russo-Japanese War.

BUILT.

Type.	Great Britain.	France.	Germany.	Russia.	Italy.	United States.	Japan.
Battleships, 1st class	49	20	14	12	12	12	6
" 2nd class	4	9	4	2	—	1	1
" 3rd class	2	1	12	1	5	—	—
Coast defence vessels	2	14	11	13	—	15	2
Cruisers, armored	24	10	2	6	5	2	8§
" protected, 1st class	21	7	1	2	—	3	—
" " 2nd class	51†	16	8	4	5	12	10
" " 3rd class	32‡	17	10	—	11	2	7
" unprotected	10	1	20	3	—	11	9
Torpedo vessels	34	16	2	8	14	—	1
Torpedo-boat destroyers	112	14	32	40	11	20	17
Torpedo boats	85	247	93	150	145	27	63
Submarines	5	15	—	—	1	3	—

BUILDING.

Type.	Great Britain.	France.	Russia.	Germany.	Italy.	United States.	Japan.
Battleships, 1st class	7 6*	6	6 6*	6	6 3*	7 5*	4*
" 2nd class	—	—	—	—	—	—	—
Coast defence vessels	—	—	—	—	—	1	—
Cruisers, armored	13 4*	12 1*	3*	3 1*	1	11	6*
" protected, 1st class	—	—	2 2*	—	—	—	—
" " 2nd class	2	—	2	—	—	5	2
" " 3rd class	4 3*	—	—	5 2*	1*	—	1
Scouts	4 4*	—	—	—	—	1*	—
Torpedo-boat destroyers	19 15*	19 4*	6	6*	2*	—	2
Torpedo-boats	5	18 25*	7	—	8	4	18
Submarines	4 10*	25 18*	2	1	2	5	—

RELATIVE ORDER OF WAR SHIP STRENGTH.

At Present.		As would be the Case were Vessels Building now Completed.	
Nation.	**Tonnage.**	**Nation.**	**Tonnage.**
Great Britain	1,516,040	Great Britain	1,867,250
France	576,108	France	755,757
Germany	387,874	United States	616,275
Russia	346,458	Germany	505,619
United States	294,405	Russia	458,432
Italy	258,838	Italy	329,257
Japan	243,586	Japan	253,681
Austria	93,913	Austria	149,833

* Signifies programme 1903-4 (ordered or projected).
† Including three partially protected.
‡ Including one partially protected.
§ Including two vessels purchased from the Argentine for $7,500,000, Dec. 31st, 1903.

SEA STRENGTH OF THE PRINCIPAL NAVAL POWERS.

JANUARY 1, 1904.

ISSUED BY THE OFFICE OF NAVAL INTELLIGENCE, U. S. N.

NUMBER AND DISPLACEMENT OF WAR SHIPS, BUILT AND BUILDING, OF 1,000 OR MORE TONS DISPLACEMENT.

TYPE.	Great Britain.				France.				Russia.				Germany.			
	Built.	Tons.	B'ld-ing.	Tons.	Built.	Tons.	B'ld-ing.	Tons.	Built.	Tons.	B'ld-ing.	Tons.	Built.	Tons.	B'ld-ing.	Tons.
Battleships, 1st class*	50	669,000	9	142,600	20	223,621	6	87,800	17	201,129	8	112,864	14	152,581	6	77,982
Other battleships and coast defense ironclads........	6	49,900	....	....	20	94,615	....	....	12	66,679	....	....	16	90,773	....	....
Armored cruisers...	27	262,800	14	166,000	15	113,767	8	91,849	8	71,261	....	....	3	28,144	3	28,048
Protected cruisers, 1st class (above 6,000 tons)......	21	201,950	....	....	4	31,513	....	....	6	39,546	3	19,965	....	....	....	....
Protected cruisers, 2d class (3,000 to 6,000 tons)......	53	235,880	7	21,000	19	79,752	....	....	5	19,450	3	9,445	9	46,949	....	....
Other cruisers and scouts (above 1,000 tons)......	44	96,510	8	21,610	18	32,840	....	....	11	18,093	....	....	31	69,427	4	11,715
Totals.........	201	1,516,040	38	351,210	96	576,108	14	179,649	59	416,158	14	142,274	73	387,874	13	117,745
Combined totals	239 of 1,867,250 tons.				110 of 755,757 tons.				73 of 558,432 tons.				86 of 505,619 tons.			

TYPE.	United States.				Italy.				Japan.				Austria.			
	Built.	Tons.	B'ld-ing.	Tons.	Built.	Tons.	B'ld-ing.	Tons.	Built.	Tons.	B'ld-ing.	Tons.	Built.	Tons.	B'ld-ing.	Tons.
Battleships, 1st class*	11	125,129	11†	166,700	14	173,276	5	63,125	6	84,300	.....	....	.....	....	3	31,800
Other battleships and coast defense ironclads........	12	47,945	.....	....	3	12,244	.....	....	3	13,004	.....	....	11	62,480	2	16,720
Armored cruisers...	2	17,415	8	111,800	5	31,891	1	7,264	8	73,550	.....	....	2	11,520	1	7,400
Protected cruisers, 1st class (above 6,000 tons)......	2	14,750	3	28,800	.....	....	.....	....	.....	....	.....	....	.....	....	.....	....
Protected cruisers, 2d class (3,000 to 6,000 tons)......	15	56,393	4	12,400	5	17,490	.....	....	10	41,226	3	10,095	2	8,128	.....	....
Other cruisers and scouts (above 1,000 tons)......	23	32,773	2	2,170	11	23,937	.....	....	17	31,506	.....	....	6	11,785	.....	....
Totals.........	65	294,405	28	321,870	38	258,838	6	70,419	44	243,586	3	10,095	21	93,913	6	55,920
Combined totals	93 of 616,275 tons.				44 of 329,257 tons.				47 of 253,681 tons.				27 of 149,833 tons.			

* Battleships, first class, are of (about) 10,000 tons, or more, displacement, and are not more than 20 years old. (The few exceptions as to age have been reconstructed and are given a modern armament.)

† Contract not yet awarded for two additional authorized.

N. B.—Gunboats and other vessels of less than 1,000 tons are not given in the table. nor are transports, despatch vessels, converted merchant vessels or yachts, or obsolete cruisers. Vessels not begun are not included in the table. For later figures see page 58.

NUMBER OF TORPEDO VESSELS AND SUBMARINES, BUILT AND BUILDING.

TYPE.	Great Britain. Built.	Great Britain. Building.	France. Built.	France. B'ld-ing.	Russia. Built.	Russia. B'ld-ing.	Germany. Built.	Germany. B'ld-ing.	United States. Built.	United States. Building.	Italy. Built.	Italy. B'ld-ing.	Japan. Built.	Japan. B'ld-ing.	Austria. Built.	Austria. B'ld-ing.
Torpedo boat destroyers....	125	21	25	13	40	9	32	12	16	..	11	2	17	..	7	....
Torpedo boats..........	90	..	260	30	150	5	93	..	30	4	142	8	63	18	61	....
Submarines............	9	10	30	10	1	..	..	3	8	..	1	2	..	..	1	....
Totals................	224	31	315	53	191	14	125	15	54	4	154	12	80	18	69	....
Combined totals......	255		368		205		140		58		166		98		69	

THE NAVIES OF THE WORLD IN DETAIL.

ARGENTINE REPUBLIC.

PERSONNEL.—There are 321 executive officers and 158 engineer officers on the active list, and from 5,000 to 6,000 men. The executive officers are divided as follows: 1 vice-admiral, 2 rear-admirals, 3 commodores, 11 captains, 42 commanders, 30 lieutenants, 91 sub-lieutenants, 81 midshipmen, and 60 cadets.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903 was:—

BUILT.

Battleships......................	1
Coast defence vessels.............	4
Armored cruisers.................	4
Protected cruisers................	5
Torpedo vessels..................	5
Torpedo-boat destroyers...........	3
Torpedo boats....................	22

BUILDING.

*Armored cruisers.................	2

DOCKYARDS.—The principal dockyards are situated as follows:—

San Fernando.—Three small docks take cruisers.

Puerto Belgrano.—One large dock takes battleships.

Buenos Ayres.—Very limited accommodation.

AUSTRIA-HUNGARY.

PERSONNEL.—The number of all ranks in the Austrian Navy,including reserves, is10,841. The officers of the Austrian Navy are distributed as follows: 1 admiral, 2 vice-admirals, 17 captains, 27 commanders, 37 lieutenant-commanders, 200 lieutenants, 191 sub-lieutenants, and 180 midshipmen.

MATERIEL.—The strength in ships built, building, and projected on Nov. 30th, 1903, was:—

BUILT.

Battleships, 3rd class	5
Coast defence ships...............	3
River monitors....................	4
Armored cruisers..................	1
Protected cruisers, 2nd class........	2
" " 3rd class........	4
Torpedo vessels...................	15
Torpedo boats....................	37

BUILDING.

Battleships, 1st class..............	4
Monitors.........................	2
Armored cruisers..................	1
Torpedo vessels..................	5

DOCKYARD.—The principal Government dockyard of Austria-Hungary is situated at Pola. There are three small docks there.

* These two vessels are the *Bernadino Rivadavia* and the *Mariano Moreno*, which were built in Italy, and were sold (Dec. 31st, 1903) to the Japanese Government.

BRAZIL.

PERSONNEL.—The personnel of the Brazilian navy numbers about 8,500 of all ranks. The executive officers are distributed as follows: 1 admiral, 2 vice-admirals, 10 rear-admirals, 18 captains, 30 commanders, 60 lieutenant-commanders, 175 lieutenants, and 160 sub-lieutenants.

MATERIEL.—The ships built for the Brazilian Navy number in all 63. There are no vessels under construction.

BUILT.

Coast defence ships	9
Protected cruisers	6
Torpedo vessels	18
Torpedo boats	28
Submarines	2

DOCKYARDS.—The only important dockyard is situated at Rio de Janeiro, where there are three docks to take cruisers, and two smaller ones. Besides this there are naval bases at Para, Bahia, Pernambuco, and Ladario de Matto Grosso.

CHILE.

PERSONNEL.—The numbers of officers and men on the active list are variously stated to be from 6,000 to 8,000. The executive officers are distributed as follows: 1 vice-admiral, 4 rear-admirals, 11 captains, 18 commanders, 16 lieutenant-commanders, 25 lieutenants, and 36 midshipmen.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

Battleships	2
Armored cruisers	2
Protected cruisers	6
Torpedo vessels	5
Torpedo-boat destroyers	6
Torpedo boats	24

DOCKYARDS.—The principal dockyards are situated as follows:—

Talcahuno.—One dock takes any warship.
Valparaiso.—Two small floating docks take cruisers.

DENMARK.

PERSONNEL.—The personnel numbers about 4,000 of all ranks. The executive officers are divided as follows: 1 vice-admiral, 2 rear-admirals, 16 captains, 38 commanders, 63 lieutenants, 33 sub-lieutenants, and 23 midshipmen.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

Battleships	4
Coast defence vessels	4
Protected cruisers	5
Torpedo boats	25

BUILDING.

Coast defence vessel	1

DOCKYARD.—At Copenhagen there are three small docks.

FRANCE.

PERSONNEL.

The number of officers and men on the active list of the French Navy in 1903 was 53,247, and in the Reserve there were 49,346 officers and men. The number of men effective during 1903 was less by 2,940 than the number available during the preceding year.

The executive officers of the French Navy are divided as follows:—15 vice-admirals, 30 rear-admirals, 124 captains, 212 commanders, 751 lieutenant-commanders, 574 lieutenants, 146 sub-lieutenants, 100 midshipmen, 183 cadets.

MATERIEL.

The number of ships built, building, and projected for the French Navy on Nov. 30th, 1903, was:—

BUILT.

Battleships, 1st class	20
" 2nd class	9
" 3rd class	1
Coast defence vessels	14
Armored cruisers	10
Protected cruisers, 1st class	7
" " 2nd class	16
" " 3rd class	17
Unprotected cruisers	1
Torpedo vessels	16
Torpedo-boat destroyers	14
Torpedo boats	247
Submarines	15

BUILDING.

Battleships, 1st class	6
Armored cruisers	12
Torpedo-boat destroyers	19
Torpedo-boats	18
Submarines	25

PROJECTED.

Armored cruiser*	1
Torpedo-boat destroyers	4
Torpedo boats	25
Submarines	18

DOCKYARDS.

The Government dockyards in France are situated as follows:—

Cherbourg.—One dock takes battleships 14,000 tons; seven smaller.
Brest.—One dock takes battleships; others very small.
Lorient.—One dock takes battleships 14,000 tons; one takes small cruisers.
Rochefort.—Three docks, take small vessels only.
Toulon.—Three docks take battleships 14,000 tons; six others take cruisers.

GERMANY.

PERSONNEL.

The number of officers and men on the active list is 35,685, and on the regular reserve there are 5,114. The total number of able-bodied men liable for service in the Reserve, however, is about 70,000.

* This armored cruiser is the *Ernest Renan* of 13,562 tons.

The executive officers of the German Navy are divided as follows:—8 vice-admirals, 16 rear-admirals, 58 captains, 125 commanders, 245 lieutenant-commanders, 382 lieutenants, 332 sub-lieutenants, 401 midshipmen, 200 cadets.

MATERIEL.

The strength of the German Navy in ships built and building on Nov. 30th, 1903, was:—

BUILT.

Battleships, 1st class	14
" 2nd class	4
" 3rd class	12
Coast defence ships	11
Armored cruisers	2
Protected cruisers, 1st class	1
" " 2nd class	8
" " 3rd class	10
Unprotected cruisers	20
Torpedo vessels	2
Torpedo-boat destroyers	32
Torpedo boats	93
Submarines	?

BUILDING.

Battleships, 1st class	6
Armored cruisers	3
Protected cruisers, 3rd class	5

PROJECTED.

Armored cruiser*	1
Protected cruisers	2
Torpedo-boat destroyers	6
Torpedo boats	—
Submarine	1

DOCKYARDS.

The German dockyards are situated as follows:—

Kiel.—Two docks take any ship. Also two floating docks. Four docks take any ship up to 10,000 tons.

Wilhelmshaven.—One dock takes any ship; one takes up to 10,000 tons. Three floating docks; two new ones building.

GREAT BRITAIN.

PERSONNEL.

The number of officers, seamen, boys, and marines provided for sea and other services for the year 1903-4 amounts to 127,100, being an increase of 4,600 on the previous year. The strength of the Royal Marines on Jan. 1st, 1903, was 19,579.

The passing of the Naval Forces Act during the year will strengthen the Naval Reserves by increasing its numbers, and by authorizing short-service system in the Navy, on condition that those accepting such employment shall complete a term of seven years in the reserve. The Royal Naval Volunteers authorized by the Act of 1902 have commenced enrolment, and Divisions have been formed at London and Glasgow.

MATERIEL.

The strength of the British Navy in ships built, building, and projected on Nov. 30th, 1903, was:—

BUILT.

Battleships, 1st class	49
" 2nd class	4
" 3rd class	2
Coast defence ships	2
Armored crusiers	24
Protected cruisers, 1st class	21
" " 2nd class	51
" " 3rd class	32
Unprotected cruisers	10
Torpedo vessels	34
Torpedo-boat destroyers	112
Torpedo boats	85
Submarines	5

BUILDING.

Battleships, 1st class	7
Armored cruisers	13
Protected cruisers, 2nd class	2
" " 3rd class	4
Scouts	4
Torpedo-boat destroyers	19
Torpedo boats	5
Submarines	4

PROJECTED.

Battleships, 1st class	6
Armored cruisers	4
Protected cruisers	3
Scouts	4
Torpedo-boat destroyers	15
Submarines	10

Two of the first-class battleships are those purchased from Chile.

DOCKYARDS.

The public dockyards in Great Britain are situated as follows:—

Portsmouth.—Six docks take any ship; three take armored cruisers, 10,000 tons and smaller.

Devonport.—Two docks take battleships; two smaller.

Keyham.—One dock takes small battleships; three smaller.

Chatham.—Six docks take battleships (four small ones only); four smaller.

Sheerness.—Five small docks.

Pembroke.—One dock takes small battleships.

Haulbowline.—Two docks take any ship.

ITALY.

PERSONNEL.

There are 26,948 officers and men on the active list for the current financial year, and the reserve numbers 33,667 officers and men. This latter is, however, of doubtful efficiency, for many of the officers are over sixty-five years of age, and the men have but little training.

The executive officers of the Italian Navy are divided as follows:—1 admiral, 7 vice-admirals, 14 rear-admirals, 58 captains, 70 commanders, 75 lieutenant-commanders, 410 lieutenants, 160 sub-lieutenants, 130 midshipmen.

MATERIEL.

The strength of ships built, building and projected on Nov. 30th, 1903, was:—

BUILT.

Battleships, 1st class	12
" 3rd class	5
Armored cruisers	5
Protected cruisers, 2nd class	5
" " 3rd class	11
Torpedo vessels	14
Torpedo-boat destroyers	11
Torpedo boats	145
Submarines	1

BUILDING.

Battleships, 1st class	6
Armored cruisers	1
Submarines	1

PROJECTED.

Battleships, 1st class	3
Protected cruisers, 3rd class	1
Torpedo-boat destroyers	2
Torpedo boats	8
Submarines	1

DOCKYARDS.

The Government dockyards of Italy are situated as follows:—

Spezia.—One dock takes any ship; one takes all Italian ships; four smaller.

Venice.—One dock takes cruisers; one smaller. One building to take any ship.

Taranto.—One dock takes any ship.

JAPAN.

PERSONNEL.

The number of officers and men available for active service is about 31,000. There is also a small reserve of some 4,000.

MATERIEL.

The strength in ships built, building, and projected on Nov 30th, 1903, less loss, was:—

BUILT.

Battleships, 1st class	6
" 2nd class	1
Coast defence ships	2
Armored cruisers	8*
Protected cruisers, 2nd class	10
" " 3rd class	7
Unprotected cruisers	9
Torpedo vessels	1
Torpedo-boat destroyers	17
Torpedo boats	63

BUILDING.

Protected cruisers, 2nd class	2
" " 3rd class	1
Torpedo-boat destroyers	2
Torpedo boats	18

PROJECTED.

Battleships,† 1st class	4
Armored cruisers	6

DOCKYARDS.

The Government dockyards in Japan are situated as follows:—

Yokosuka.—One dock takes any ship; two smaller.

Kure.—One dock takes cruisers.

*Including two vessels, each of 7700 tons displacement and a speed of 20 knots, purchased from the Argentine Government for $7,500,000 (Dec. 31st, 1903).

† The projected vessels have not been named.

NETHERLANDS.

PERSONNEL.—The total of officers and men enlisted for the navy reaches 11,000, but this figure includes the marine infantry. The executive officers are divided as follows: 1 vice-admiral, 3 rear admirals, 25 captains, 40 commanders, 400 lieutenants and sub-lieutenants, and 200 midshipmen.

MATERIEL.—The strength in ships built, building and projected on Nov. 30th, 1903, was:—

BUILT.

Battleships, 3rd class	2
Coast defence ships	19
Unprotected cruisers	11
Torpedo vessels	12
Torpedo boats	29

BUILDING.

Coast defence ships	2
Torpedo boats	5

PROJECTED.

Coast defence ships	3
Torpedo vessels	7
Torpedo boats	2
Submarine (to be purchased)	1

DOCKYARDS.—The principal dockyards are situated as follows:

Helder.—Two docks take cruisers.

Hellevoetsluis.—One dock takes small battleships.

Amsterdam.—Two floating docks take cruisers.

Rotterdam.—Three floating docks take small cruisers.

NORWAY.

PERSONNEL.—The personnel numbers about 2,000, of which 1,000 are permanent, and the remainder yearly conscripts. The executive officers are divided as follows: 1 rear-admiral, 4 captains, 14 commanders, 28 lieutenant-commanders, 37 lieutenants, 30 sub-lieutenants.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

Coast defence vessels	4
Torpedo vessels	7
Torpedo boats	26

BUILDING.

Coast defence vessel	1
Torpedo boats	2
Submarine	1

DOCKYARDS.—The principal dockyards of Norway are situated as follows:—

Horten.—One dry dock takes small battleships.

Christiansand.—One dry dock takes small battleships.

PORTUGAL.

PERSONNEL.—The number of men in the Portuguese Navy is about 5,000, and, in addition, there are 2 vice-admirals, 5 rear-admirals, 16 captains, 25 commanders, 25 lieutenant-commanders, 80 lieutenants, 110 sub-lieutenants, 37 midshipmen, and 96 cadets. The age for retirement of a vice-admiral is 70 years, rear-admiral 66 years, and other officers 64 years.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

Battleship	1
Unprotected cruisers	7
Torpedo vessels	14
Torpedo boats	11

BUILDING.

Torpedo vessels	2

DOCKYARD.—There are four small docks at Lisbon.

RUSSIA.

PERSONNEL.

There are 2,900 officers on the effective list of the Russian Navy, and the number of men is 61,516. In the Reserve there are about 30,000 of all ranks.

The executive officers of the Russian Navy are divided as follows:—1 commander-in-chief (admiral-general), 14 admirals, 24 vice-admirals, 33 rear-admirals, 92 captains, 212 commanders, 850 lieutenants, 400 midshipmen.

MATERIEL.

The strength of the Russian Navy in ships built, building and projected, on Nov. 30th, 1903, less losses, was:—

BUILT.

Battleships, 1st class	12
" 2nd class	2
" 3rd class	1
Coast defence ships	13
Armored cruisers	6
Protected cruisers, 1st class	2
" " 2nd class	4
" " 3rd class	—
Unprotected cruisers	3
Torpedo vessels	8
Torpedo-boat destroyers	40
Torpedo boats	150
Submarines	0

BUILDING.

Battleships, 1st class	6
Armored cruisers	0
Protected cruisers, 1st class	2
" " 2nd class	2
Torpedo-boat destroyers	6
Torpedo-boats	7
Submarines	2

PROJECTED.

Battleships, 1st class	6
Armored cruisers	3
Protected cruisers, 1st class	2

The projected battleships are the *Tchesma*, *Evstafi* and *Ioann Zlatoust*, all of which are reported to have been laid down in the Black Sea yards; and the *Imperator Pavel*, the *Andrei Pervosvannui*, to be built in the St. Petersburg yards. Of the sixth vessel nothing is yet known, nor have the names of the armored cruisers transpired. The protected cruisers are to be of the *Kagul* type.

[The war with Japan has modified all figures of present strength.]

DOCKYARDS.

The principal Russian dockyards are situated as follows:—

Kronstadt.—One dock takes any ship; three smaller.
Libau.—Two docks take any ship.
Sevastopol.—Two docks take any ship.

SPAIN.

PERSONNEL.—There are 16,700 of all ranks in the Spanish Navy, and 9,000 marines. All these are conscripts. The officers are divided as follows: 1 admiral, 4 vice-admirals, 11 rear-admirals, 22 captains, 47 commanders, 94 lieutenant-commanders, 131 lieutenants, 340 sub-lieutenants, 165 midshipmen, and 100 cadets.

MATERIEL.—The strength in ships built and building on Nov. 30th, 1903, was:—

BUILT.

Battleship	1
Armored cruisers	2
Protected cruisers	6
Torpedo vessels	17
Torpedo-boat destroyers	4
Torpedo boats	10

BUILDING.

Armored cruisers	2
Protected cruisers	2

DOCKYARDS.—The principal dockyards are situated as follows:—

Cadiz.—Three docks take cruisers.
Cartagena.—One floating dock takes large cruisers.
Bilboa.—One dock takes any Spanish ship; two smaller.

SWEDEN.

PERSONNEL.—The personnel of the Swedish Navy in 1903 numbered about 7,500 of all ranks. In addition there are about 20,000 yearly conscripts available, but the majority of these are seldom called upon. The officers are divided as follows: 1 vice-admiral, 4 rear-admirals, 6 commodores, 24 captains, 64 commanders, 55 lieutenants, 30 sub-lieutenants.

MATERIEL.—The strength of ships built and building on Nov. 30th was:—

BUILT.

Coast defence vessels	10
Torpedo vessels	14
Torpedo-boat destroyer	1
Torpedo boats	28

BUILDING.

Battleship	1
Armored cruiser	1
Torpedo boats	3
Submarine	1

DOCKYARDS.—The principal dockyards in Sweden are situated as follows:—

Karlscrona.—Three docks take any Swedish ship; three smaller.

Stockholm.—One dock takes cruisers.

TURKEY.

PERSONNEL.—There are 31,000 officers and men in the Turkish Navy and 9,000 marines. The officers are divided as follows: 2 admirals, 9 vice-admirals, 16 rear-admirals, 30 captains, 90 commanders, 300 lieutenant-commanders, 250 lieutenants, 200 sub-lieutenants.

MATERIEL.—The strength in ships built and building for the Turkish Navy on Nov. 30th, 1903, was:—

BUILT.

Battleships	—
Protected cruiser	1
Torpedo vessels	6
Torpedo-boat destroyers	2
Torpedo boats	25
Submarines	2

BUILDING.

Protected cruisers	5
Torpedo-boat destroyers	2

UNITED STATES.

ADMINISTRATION.

The President of the United States is *ex-officio* Commander-in-chief of the Navy. As his executive he appoints a Secretary of the Navy, a member of his Cabinet, on a four years' term. He also appoints an Assistant Secretary of the Navy, and these two political officials, who are usually civilians, exercise a general control and supervision of the ten departments or bureaus among which the business is distributed. These departments are very similar to those in the British Admiralty, and they are almost all of them under the direction of naval officers. There are also special boards, mostly departmental, who advise either the Secretary of the Navy or the chiefs of the bureaus on technical points. There is nothing approximating to the headquarters staff which is found in all naval administrations, based on the precedent of the organization of land forces. In this respect the naval administration of the United States and Great Britain differ from almost all the rest. With regard to the estimates, the chiefs of the various bureaus prepare and make annually reports which are published, and in these reports they make recommendations with estimates of cost. The Secretary of the Navy also makes an annual report, summarizing the reports of his subordinates, with his own recommendations, which are submitted to Congress in the shape of Bills, which, being passed by the House of Representatives and the Senate, and approved by the President, become law. The United States Navy is manned by voluntary enlistment.

FINANCE.

The proposed estimates for 1904-5 total $102,866,449, those for 1903-4 having been $79,039,331. It is proposed to devote to new construction the sum of $28,826,860.

PERSONNEL.

The number of officers and men on the effective list of the United States Navy is 29,838, inclusive of 7,000 marines. There is a reserve in course of formation, but it is not yet in working order.

The executive officers of the United States Navy are distributed as follows:—1 admiral, 1 vice-admiral, 21 rear-admirals, 73 captains, 114 commanders, 172 lieutenant-commanders, 350 lieutenants, 100 second-lieutenants, 130 ensigns, 90 naval cadets at sea.

MATERIEL.

The strength in ships of the United States Navy built, building and projected, is separately treated.

DOCKYARDS.

The Government dockyards in the United States are situated as follows:—

Brooklyn.—One dock takes any ship; two smaller.

Norfolk, Va.—One dock takes any ship; one smaller.

Mare Island, Cal.—One dock takes any ship.

Boston, Mass.—One small dock.

League Island, Pa.—One large wooden dock.

Portsmouth, N. H.—One small dock.

—*Hazell's Annual*, 1904.

THE UNITED STATES NAVY.

On January 1, 1904, there was upon the active list 1 admiral, 27 rear admirals, 80 captains, 120 commanders, 192 lieut.-commanders, 331 lieutenants, 24 lieutenants (junior grade), 166 ensigns, 101 midshipmen, 16 medical directors, 15 medical inspectors, 86 surgeons, 35 passed assistant surgeons, 68 assistant surgeons, 14 pay directors, 15 pay inspectors, 76 paymasters, 30 passed assistant paymasters, 18 assistant paymasters, 23 chaplains, 12 professors of mathematics, 1 secretary to the admiral, 20 naval constructors, 30 assistant naval constructors, 28 civil engineers, 5 assistant civil engineers, 12 chief boatswains, 116 boatswains, 12 chief gunners, 100 gunners, 14 chief carpenters, 73 carpenters, 7 chief sailmakers, 150 warrant machinists, 25 pharmacists, and 16 mates. There were also 649 midshipmen on probation at the Naval Academy at Annapolis, Md.

REGULATIONS GOVERNING THE ADMISSION OF CANDIDATES INTO THE NAVAL ACADEMY AS MIDSHIPMEN.

NOMINATION.

The students of the Naval Academy are styled Midshipmen. Two Midshipmen are allowed for each Senator, Representative, and Delegate in Congress, two for the District of Columbia, and five each year from the United States at large. The appointments from the District of Columbia and five each year at large are made by the President. One Midshipman is allowed from Porto Rico, who must be a native of that island. The appointment is made by the President, on the recommendation of the Governor of Porto Rico. The Congressional appointments are equitably distributed, so that in regular course each Senator, Representative, and Delegate in Congress may appoint one Midshipman during each Congress. After June 30, 1913, each Senator, Representative, and Delegate in Congress will be allowed to appoint but one Midshipman instead of two. The course for Midshipmen is six years—four years at the Academy, when the succeeding appointment is made, and two years at sea, at the expiration of which time the examination for final graduation takes place. Midshipmen who pass the examination for final graduation are appointed to fill vacancies in the lower grades of the Line of the Navy and of the Marine Corps, in the order of merit as determined by the Academic Board of the Naval Academy.

"The Secretary of the Navy shall, as soon as practicable after the fifth day of March in each year, notify in writing each Senator, Representative, and Delegate in Congress of any vacancy which may be regarded as existing in the State, District, or Territory which he represents, and the nomination of a candidate to fill such vacancy shall be made upon the recommendation of the Senator, Representative, or Delegate. Such recommendation shall be made by the first day of June of that year, and if not so made the Secretary of the Navy shall fill the vacancy by the appointment of an actual resident of the State, District, or Territory in which the vacancy exists, who shall have been for at least two years immediately preceding his appointment an actual bona fide resident of the State, District, or Territory in which the vacancy exists, and shall have the qualifications otherwise prescribed by law."

(*Act approved March* 4, 1903.)

Candidates allowed for Congressional Districts, for Territories, and for the District of Columbia must be actual residents of the Districts or Territories, respectively, from which they are nominated.

All candidates must, at the time of their examination for admission, be between the ages of sixteen and twenty years. A candidate is eligible for appointment on the day he becomes sixteen, and is ineligible on the day he becomes twenty years of age.

EXAMINATION.

"*All candidates for admission into the Academy shall be examined according to such regulations and at such stated times as the Secretary of the Navy may prescribe. Candidates rejected at such examination shall not have the privilege of another examination for admission to the same class unless recommended by the Board of Examiners.*" (*Rev. Stat., Sec.* 1515.)

When any candidate, who has been nominated upon the recommendation of a Senator, Member, or Delegate of the House of Representatives, is found, upon examination, to be physically or mentally disqualified for admission, the Senator, Member, or Delegate shall be notified to recommend another candidate, who shall be examined according to the provisions of the preceding section.

Beginning with the year nineteen hundred and four, but two examinations for admission of Midshipmen to the Academy will be held each year, as follows:

1. The first examination to be held on the third Tuesday in April, under the supervision of the Civil Service Commission, at points given in a list furnished by the Bureau of Navigation, Navy Department, Washington, D. C., who also furnish sample examination papers. Candidates are examined mentally *only* at this examination. All those qualifying mentally who are entitled to appointment in order of nomination will be notified by the Superintendent of the Naval Academy to report at the Academy for physical examination on or about June 10, and if physically qualified will be appointed.

Candidates nominated for the April examination may be examined at Washington, D. C., if so desired, or at any of the places in any State named in the above schedule.

Senators and Representatives are requested, when designating their nominees, to give the place at which it is desired they should be examined if nominated for the April examination.

2. The second and last examination will be held at Annapolis, Md., *only*, on the third Tuesday in June, under the supervision of the Superintendent of the Naval Academy. Candidates are examined mentally at this examination, and all those entitled to appointment will be directed to report for physical examination, as soon as practicable, at the Naval Academy.

Alternates are given the privilege of reporting for examination at the same time with the principal.

No examination will be held later than the third Tuesday in June.

The large number of Midshipmen to be instructed and drilled makes this rule necessary, and it is to the great advantage of the new Midshipmen themselves. The summer months are utilized in preliminary instruction in professional branches and drills, such as handling boats under oars and sails, and in seamanship, gunnery, and infantry drills. These practical exercises form most excellent groundwork as a preparation for the academic course.

The examination papers used in all examinations are prepared at the Naval Academy and the examination marks made by candidates finally passed upon by the officials of the Academy.

Under the law, candidates failing to pass the entrance examination will not be allowed another examination for admission to the same class unless recommended for re-examination by the Board of Examiners.

The Civil Service Commission only conducts the examination of candidates whose names have been furnished by the Navy Department. It is requested that all correspondence relative to the nomination and examination of candidates be addressed to the Bureau of Navigation, Navy Department.

Nominations for examination on the third Tuesday in April should be forwarded to the Bureau ten days prior to the date of examination, as that is the latest date on which arrangements can be made for the examination.

Candidates will be required to enter the Academy immediately after passing the prescribed examination.

No leave of absence will be granted to Midshipmen of the fourth class.

Candidates will be examined physically at the Naval Academy by a board composed of three medical officers of the Navy.

Attention will also be paid to the stature of the candidate, and no one *manifestly* under size for his age will be received at the Academy. In the case of doubt about the physical condition of the candidate, any marked deviation from the usual standard of height or weight will add materially to the consideration for rejection. The height of candidates for admission shall not be less than 5 feet 2 inches between the ages of 16 and 18 years, and not less than 5 feet 4 inches between the ages of 18 and 20 years.

Candidates will be examined mentally in punctuation, spelling, arithmetic, geography, English grammar, United States history, world's history, algebra through quadratic equations, and plane geometry (five books of Chauvenet's Geometry, or an equivalent). Deficiency in any one of these subjects may be sufficient to insure the rejection of the candidate.

ADMISSION.

Candidates who pass the physical and mental examinations will receive appointments as Midshipmen, and become students of the Academy. Each Midshipman will be required to sign articles by which he binds himself to serve in the United States Navy eight years (including his time of probation at the Naval Academy), unless sooner discharged.

The pay of a Midshipman is $500 a year, commencing at the date of his admission.

The cruisers are the light cavalry of the navy. As their name implies, their duty is to cruise the seas, keeping in touch with the enemy's fleets and acting as the "eyes" of the line-of-battle ships. They are also intended for the double duty of attacking an enemy's commerce and defending that of the country whose flag they carry. Fleets of merchant vessels or of transport ships will be "convoyed" by cruisers from port to port.

LIST OF SHIPS OF THE UNITED STATES NAVY.

[ABBREVIATIONS.—*Hull:* S., steel; S. W., steel, wood sheathed; I., iron; W., wood. *Propulsion:* S., screw; T. S., twin screw; Tr. S., triple screw; P., paddle.]

FIRST RATE.

Name.	Displacement (tons).	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).
Maine	12,500	1st class battleship	S.	16,000	T.S.	20
Missouri	12,500	....do.	S.	16,000	T.S.	20
Alabama	11,525	....do.	S.	11,366	T.S.	18
Illinois	11,525	....do.	S.	11,366	T.S.	18
Wisconsin	11,525	....do.	S.	10,000	T.S.	18
Kearsarge	11,525	....do.	S.	11,954	T.S.	22
Kentucky	11,525	....do.	S.	12,318	T.S.	22
Iowa	11,340	....do.	S.	12,105	T.S.	18
Indiana	10,288	....do.	S.	9,738	T.S.	16
Massachusetts	10,288	....do.	S.	10,403	T.S.	16
Oregon	10,288	....do.	S.	11,111	T.S.	16
Brooklyn	9.215	Armored cruiser	S.	18,769	T.S.	20
New York	8,200	....do.	S.	17,401	T.S.	18

SECOND RATE.

Name.	Displacement (tons).	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).
Columbia	7,375	Protected cruiser	S.	18,509	Tr.S.	11
Minneapolis	7,375	....do.	S.	20,862	Tr.S.	11
Texas	6,315	2d class battleship	S.	8,610	T.S.	8
Puritan	6,060	Double-turret monitor.	I.	3,700	T.S.	10
Olympia	5,870	Protected cruiser	S.	17,313	T.S.	14
Chicago	5,000	....do.	S.	9,000	T.S.	18
Yankee	6,888	Cruiser (converted)	I.	3,800	S.	10
Prairie	6,872	....do.	I.	3,800	S.	10
Buffalo	6,888	....do.	S.	3,600	S.	6
Dixie	6,145	....do.	S.	3,800	S.	10
Baltimore	4,413	Protected cruiser	S.	10,064	T.S.	12
Philadelphia	4,324	....do.	S.	8,815	T.S.	12
Newark	4,098	....do.	S.	8,869	T.S.	12
San Francisco	4,098	....do.	S.	9,913	T.S.	12
Monterey	4,084	Barbette turret, low free-board monitor.	S.	5,244	T.S.	4
Monadnock	4,005	Double-turret monitor.	I.	3,000	T.S.	6

THIRD RATE.

Name.	Displacement (tons).	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).
Ajax	*7,500	Collier	S.	3,000	S.	†2
Glacier	*7,000	Refrigerator ship	S.	4,000	S.	..
Celtic	6,428	....do.	S.	1,890	S.	..
Culgoa	*6,300	Supply ship	S.	†1,500	..	..
Saturn	*6,220	Collier	I.	1,500	S.	†2
Rainbow	6,206	Cruiser (converted)	S.	1,800	S.	..
Arethusa	*6,200	Tank steamer	S.	.....	S.	..
Alexander	6,181	Collier	S.	1,026	S.	†2

* Estimated. † Secondary battery.

THIRD RATE—*Continued.*

Name.	Displacement (tons).	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).
Iris	6,100	Supply and repair ship.	S.	1,300	S.	..
Brutus	*6,000	Collier	S.	1,200	S.	†2
Sterling	5,663	....do	I.	*926	S.	†2
Cæsar	5,016	....do	S.	1,500	S.	†4
Nero	4,925	....do	S.	1,000	S.	†4
Nanshan	*4,827	....do	S.	.....	..	..
Abarenda	4,670	....do	S.	1,050	S.	†4
Supply	4,460	Supply ship	I.	1,069	S.	†2
Marcellus	*4,400	Collier	I.	1,200	S.	†2
Hannibal	4,291	....do	S.	1,100	S.	†2
Leonidas	4,242	....do	S.	1,000	S.	†2
Solace	4,700	Hospital ship	S.	3,200	S.	..
Panther	4,260	Cruiser (converted).	I.	..	S.	8
Miantonomoh	3,990	Double-turret monitor.	I.	1,426	T.S.	4
Amphitrite	3,990	....do	I.	1,600	T.S.	6
Terror	3,990	Double-turret monitor....	I.	1,600	T.S.	4
Albany	3,437	Protected cruiser ..	S.W.	7,500	T.S.	10
New Orleans	3,437	....do	S.W.	7,500	T.S.	10
Arkansas	3,214	Monitor	S.	2,400	T.S.	6
Wyoming	3,214	....do	S.	2,400	T.S.	6
Nevada	3,714	....do	S.	2,400	T.S.	6
Florida	3,214	....do	S.	2,400	T.S.	6
Cincinnati	3,213	Protected cruiser ..	S.	10,000	T.S.	11
Raleigh	3,213	....do	S.	10,000	T.S.	11
Cleveland	3,100	....do	S.W.	4,700	T.S.	10
Reina Mercedes	3,090	....do	S.	3,700	S.	..
Atlanta	3,000	....do	S.	4,000	S.	8
Boston	3,000	....do	S.	4,030	S.	8
Hartford	2,790	Cruiser	W.	2,000	S.	13
Mayflower	2,690	Cruiser (converted)	S.	4,700	T.S.	2
Topeka	2,372	Gunboat	I.	2,000	T.S.	8
Katahdin	2,155	Harbor defence ram	S.	5,068	T.S.	4
Detroit	2,089	Unprotected cruiser	S.	5,227	T.S.	10
Montgomery	2,089	....do	S.	5,580	T.S.	10
Marblehead	2,089	....do	S.	5,451	T.S.	10
Mohican	1,900	Cruiser	W.	1,100	S.	6
Manila	1,800	Gunboat	I.	750	S.	2
Bennington	1,710	....do	I.	3,436	T.S.	6
Concord	1,710	....do	S.	3,405	T.S.	6
Yorktown	1,710	....do	S.	3,392	T.S	6
Dolphin	1,486	Dispatch boat	S.	2,253	S.	3
Wilmington	1,392	Light draft gunb't .	S.	1,894	T.S.	8
Helena	1,392	....do	S.	1,988	T.S.	8
Adams	1,375	Cruiser	W.	800	S.	6
Essex	1,375	....do	W.	800	S.	6
Enterprise	1,375	....do	W.	800	S.	1
Nashville	1,371	Light-draft gunb't .	S.	2,536	T.S.	8
Castine	1,177	Gunboat	S.	2,199	T.S.	8
Machias	1,177	....do	S.	2,046	T.S.	8
Chesapeake	1,175	....do	Comp.	.....	Sails.	6
Don Juan de Austria	1,159	....do	I.	1,500	S.	4
Isla de Luzon	1,030	....do	S.	2,627	T.S.	6
Isla de Cuba	1,030	....do	S.	2,627	T.S.	6
Alert	1,020	Cruiser	I.	500	S.	3
Ranger	1,020	....do	I.	500	S.	6
Annapolis	1,000	Composite gunboat	Comp.	1,227	S.	6
Vicksburg	1,000	....do	Comp.	1,118	S.	6
Wheeling	1,000	....do	Comp.	1,081	T.S.	6
Marietta	1,000	....do	Comp.	1,054	T.S.	6
Newport	1,000	....do	Comp.	1,008	S.	6
Princeton	1,000	....do	Comp.	800	S.	6
Lawton	*4,100	Transport	S.	3,200	S.	..
Relief	*3,000	Hospital ship	S.	2,666	S.	..

* Estimated. † Secondary battery.

FOURTH RATE.

Name.	Displacement (tons.)	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).
Lebanon	3,375	Collier	I.	.....	S.	†4
Justin	*3,300	....do	S.	.....	S.	†2
Southery	*3,100	....do	I.	.....	S.	†2
Pompey	*3,085	....do	S.	.....	S.	†2
Zafiro	*2,000	Transport	S.	.....	....	..
General Alava	1,40	....do	S.	770	S.	†4
Yankton	975	Gunboat (conv't'd).	S.	750	S.	†8
Vesuvius	0929	Dynamite-gun vessel.	S.	3,795	T.S.	†3
Petrel	892	Gunboat	S.	1,095	S.	4
Scorpion	850	Gunboat (conv't'd).	S.	2,800	T.S.	†8
Fern	840	Tender	W.	300	S.	†3
Bancroft	839	Gunboat	S.	1,213	T.S.	4
Vixen	806	Gunboat conv't'd)	S.	1,250	S.	†4
Gloucester	786	....do	S.	2,000	S.	†10
Michigan	685	Cruiser	I.	365	P.	†6
Wasp	630	Gunboat (conv't'd)	S.	1,800	S.	†6
Frolic	607	....do	S.	550	S.	†4
Dorothea	594	....do	S.	1,558	S.	†10
Elcano	560	Gunboat	S.	600	T.S.	..
Pinta	550	....do	I.	310	S.	†2
Stranger	*546	Gunboat (conv't'd).	I.	.....	S.	†5
Peoria	488	....do	S.	.....	S.	†7
Hist	472	....do	S.	500	S.	†6
Eagle	434	....do	S.	850	S.	†6
Hornet	425	....do	S.	800	S.	†9
Quiros	400	Gunboat	Comp.	208	S.	†2
Villalobos	400	....do	Comp.	208	S.	†2
Hawk	375	Gunboat (conv't'd).	S.	1,000	S.	†4
Siren	*315	....do	S.	.....	S.	†4
Sylvia	*302	....do	I.	.....	S.	†6
Callao	200	Gunboat	S.	250	T.S.	†6
Pampanga	200	....do	I.	250	T.S.	†4
Paragua	200	....do	I.	250	T.S.	†4
Samar	200	....do	I.	250	T.S.	†4
Arayat	200	....do	I.	260	T.S.	†6
Aileen	192	Gunboat (conv't'd).	S.	500	S.	†5
Mindanao	174	Gunboat	I.	100	T.S.	†6
Elfrida	*173	Gunboat (conv't'd).	S.	200	S.	†2
Sylph	152	....do	S.	550	S.	†8
Calamianes	150	Gunboat	I.	125	T.S.	†3
Albay	150	....do	I.	125	T.S.	†3
Leyte	150	....do	I.	125	T.S.	†3
Oneida	150	Gunboat (conv't'd).	W.	350	S.	†6
Panay	142	Gunboat	I.	125	T.S.	†4
Manileño	142	....do	I.	125	T.S.	†4
Mariveles	142	....do	I.	125	T.S.	†4
Mindoro	142	....do	I.	125	T.S.	†4
Restless	137	Gunboat (conv't'd).	I.	500	S.	†8
Shearwater	122	....do	S.	.....	S.	†3
Inca	*120	....do	W.	400	S.	†2
Alvarado	100	Gunboat	S.	137	S.	†2
Sandoval	100	....do	S.	137	S.	†2
Huntress	82	Gunboat (conv't'd).	Comp.	.....	S.	†2
Basco	42	Gunboat	I.	44	S.	†2
Gardoqui	42	....do	I.	44	S.	†2
Urdaneta	42	....do	I.	44	S.	†2

* Estimated † Secondary battery.

TORPEDO VESSELS.

Name.	Displacement (tons).	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).
Decatur	420	Torpedo boat des	S.	8,000	T.S.	*2
Bainbridge	420	....do	S.	8,000	T.S.	*2
Barry	420	....do	S.	8,000	T.S.	*2
Dale	420	....do	S.	8,000	T.S.	*2
Chauncey	420	....do	S.	8,000	T.S.	*2
Whipple	433	....do	S.	8,300	T.S.	*2
Stewart	420	....do	S.	7,000	T.S.	*2
Truxtun	433	....do	S.	8,300	T.S.	*2
Worden	433	....do	S.	8,300	T.S.	*2
Hopkins	408	....do	S.	7,200	T.S.	*2
Lawrence	400	....do	S.	8,400	T.S.	*2
Hull	408	....do	S.	7,200	T.S.	*2
Macdonough	400	....do	S.	8,400	T.S.	*2
Preble	420	....do	S.	7,000	T.S.	*2
Paul Jones	420	....do	S.	7,000	T.S.	*2
Perry	420	....do	S.	7,000	T.S.	*2
Bagley	167	Torpedo boat	S.	4,200	T.S.	*3
Barney	167	....do	S.	4,200	T.S.	*3
Biddle	167	....do	S.	4,200	T.S.	*3
Ericsson	120	....do	S.	1,800	T.S.	*3
Foote	142	....do	S.	2,000	T.S.	*3
Gwin	46	....do	S.	850	S.	*2
Mackenzie	65	....do	S.	850	S.	*2
Somers	145	....do	S.	1,900	T.S.	*3
Cushing	105	....do	S.	1,720	T.S.	*3
Thornton	165	....do	S.	3,000	T.S.	*3
Stockton	166	....do	S.	3,000	T.S.	*3
De Long	165	....do	S.	3,000	T.S.	*3
Wilkes	165	Torpedo boat	S.	3,000	T.S.	*3
Rodgers	142	....do	S.	2,000	T.S.	*3
Tingey	165	....do	S.	3,000	T.S.	*3
Bailey	235	....do	S.	5,600	T.S.	*2
Shubrick	166	....do	S.	3,000	T.S.	*3
Dupont	165	....do	S.	3,400	T.S.	*3
Porter	165	....do	S.	3,400	T.S.	*3
Talbot	46½	....do	S.	850	S.	*2
Manly	30	....do	S.	250	S.	*1
Farragut	273	....do	S.	5,600	T.S.	*2
Davis	132	....do	S.	1,750	T.S.	*3
Fox	132	....do	S.	1,750	T.S.	*3
T.A.M.Craven	146	....do	S.	4,200	T.S.	*2
Dahlgren	146	....do	S.	4,200	T.S.	*2
McKee	65	....do	S.	850	S.	*2
Winslow	142	....do	S.	2,000	T.S.	*3
Morris	105	....do	S.	1,750	T.S.	*3
Stiletto	31	....do	W.	359	S.	*2
Rowan	182	....do	S.	3,200	T.S.	*3
Plunger	120	Submarine tor.boat.	S.	160	S.	*1
Porpoise	120	....do	S.	160	S.	*1
Shark	120	....do	S.	160	S.	*1
Adder	120	....do	S.	160	S.	*1
Moccasin	120	....do	S.	160	S.	*1
Grampus	120	....do	S.	160	S.	*1
Pike	120	....do	S.	160	S.	*1
Holland	73	....do	S.	150	S.	*1

* Torpedo tubes.

UNDER CONSTRUCTION.

Name.	Displacement (tons).	Type.	Hull.	I.H.P.	Propulsion.	Guns (main battery).	Place where building.
Connecticut. . . .	16,000	1st class battleship	S.	16,500	T.S.	24	Navy Yard, New York.
Kansas.	16,000	. . do.	S.	16,500	T.S.	24	New York Ship Building Co., Camden, N. J.
Louisiana.	16,000	. . do.	S.	16,500	T.S.	24	Newport News Ship Building and Dry Dock Co., N'p't News, Va.
Minnesota.	16,000	. . do.	S.	16,500	T. S.	24	Do.
Vermont.	16,000	. . do.	S.	16,500	T. S.	24	Fore River S. & E. Co., Quincy, Mass.
Georgia.	15,000	. . do.	S.W.	18,000	T. S.	24	Bath Iron Works, Bath, Me.
Nebraska.	15,000	. . do.	S.W.	18,000	T. S.	24	Moran Bros. Co., Seattle, Wash.
New Jersey.	15,000	. . do.	S.W.	18,000	T. S.	24	Fore River S. & E. Co., Quincy, Mass.
Rhode Island. . .	14,600	. . do.	S.	18,000	T. S.	24	Do.
Virginia.	14,600	. . do.	S.	18,000	T. S.	24	Newport News Ship Building and Dry Dock Co., N'p't News, Va.
Idaho.	13,000	. . do.	S.	10,000	T. S.	22	Contract not yet awarded.
Mississippi.	13,000	. . do.	S.	10,000	T. S.	22	Do.
Ohio.	12,500	. . do.	S.	16,000	T. S.	20	Union Iron Works, San Francisco, Cal.
Tennessee.	14,500	Armored cruiser.	S.	25,000	T. S.	20	Wm. Cramp & Sons, Philadelphia, Pa.
Washington.	14,500	. . do.	S.	25,000	T. S.	20	New York Ship Building Co., Camden, N. J.
California.	14,000	. . do.	S.W.	23,000	T. S.	22	Union Iron Works, San Francisco, Cal.
Pennsylvania. . .	14,000	Armored cruiser.	S.W.	23,000	T. S.	22	Wm. Cramp & Sons, Philadelphia, Pa.
West Virginia. . .	14,000	. . do.	S.W.	23,000	T. S.	22	Newport News Ship Building and Dry Dock Co., N'p't News, Va.
Colorado.	13,600	. . do.	S.	23,000	T. S.	22	Wm. Cramp & Sons, Philadelphia, Pa.
Maryland.	13,600	. . do.	S.	23,000	T. S.	22	Newport News Ship Building and Dry Dock Co., N'p't News, Va.
South Dakota. . .	13,600	do.	S.	23,000	T. S.	22	Union Iron Works, San Francisco, Cal.
Charleston.	9,600	Protected cruiser.	S.	21,000	T. S.	14	Newport News Ship Building and Dry Dock Co., N'p't News, Va.
Milwaukee.	9,600	. . do.	S.	21,000	T. S.	14	Union Iron Works, San Francisco, Cal.
St. Louis.	9,600	. . do.	S.	21,000	T. S.	14	Neafie & Levy, Philadelphia, Pa.
Chattanooga. . . .	3,100	. . do.	S.W.	4,700	T. S.	10	Navy Yard, New York.
Denver.	3,100	. . do.	S.W.	4,700	T. S.	10	Neafie & Levy, Philadelphia, Pa.
Des Moines.	3,100	. . do.	S.W.	4,700	T. S.	10	Fore River S. & E. Co., Quincy, Mass.
Galveston.	3,100	. . do.	S.W.	4,700	T. S.	10	Navy Yard, Norfolk.
Tacoma.	3,100	. . do.	S.W.	4,700	T. S.	10	Union Iron Works, San Francisco, Cal.
Dubuque.	1,085	Gunboat .	S.W.	1,050	T. S.	6	Gas Engine and Power Co., and Chas. L. Seabury & Co., consolidated, Morris Heights, N.Y.
Paducah.	1,085	. . do.	S.W.	1,050	T. S.	6	Do.
Gunboat No. 16 .	. .	. . do.	S.	. .	T. S.	. .	Contract not yet awarded.
Cumberland. . . .	1,800	Training ship	S.	. .	. .	6	Navy Yard, Boston, Mass.
Intrepid.	1,800	. . do.	S.	. .	. .	6	Navy Yard, Mare Island, Cal.
Boxer.	345	Training brigantine	W.	. .	. .	. .	Navy Yard, Portsmouth, N. H.
Stringham (No. 19)	340	Torpedo boat	S.	7,200	T. S.	*2	Navy Yard, League Island.
Goldsborough (No. 20).	247½	. . do. . . .	S.	6,000	T. S.	*2	Navy Yard, Puget Sound.
Nicholson . . . . . . (No. 30)	174	. . do.	S.	3,500	T. S.	*3	Navy Yard, New York.
O'Brien (No. 31)	174	. . do.	S.	3,500	T. S.	*3	Do.
Blakely (No. 28)	165	. . do.	S.	3,000	T. S.	*3	Geo. Lawley & Sons, South Boston, Mass.
Sotoyomo (No.9)	225	. . do.	S.	450	S.	. .	Navy Yard, Mare Island, Cal.

*Torpedo tubes.

SUMMARY OF VESSELS IN THE UNITED STATES NAVY.

VESSELS FIT FOR SERVICE, INCLUDING THOSE UNDER REPAIR.

First-class battleships	10
Second-class battleship	1
Armored cruisers	2
Armored ram	1
Single-turret harbor-defense monitors	4
Double-turret monitors	6
Protected cruisers	14
Unprotected cruisers	3
Gunboats	12
Light-draft gunboats	3
Composite gunboats	6
Training ship (Naval Academy), sheathed	1
Special class (Dolphin-Vesuvius)	2
Gunboats under 500 tons	21
Torpedo-boat destroyers	16
Steel torpedo boats	29
Submarine torpedo boats	8
Wooden torpedo boat	1
Iron cruising vessels, steam	5
Wooden cruising vessels, steam	6
Wooden sailing vessels	4
Tugs	39
Auxiliary cruisers	5
Converted yachts	23
Colliers	16
Supply ships and hospital ships	14
Total	252

VESSELS UNDER CONSTRUCTION OR AUTHORIZED.

First-class battleships	14
Armored cruisers	8
Protected cruisers	9
Gunboat for great Lakes (not begun)	1
Composite gunboats	2
Steel torpedo boats	6
Training ships	2
Training brig	1
Tugs	2
Total	45

VESSELS UNFIT FOR SEA SERVICE.

Iron single-turret monitors	5
Wooden cruising vessels, steam	10
Wooden sailing vessels	8
Total	23
Grand Total	302

THE "LAKE" SUBMARINE BOAT ON THE SURFACE.

SUBMARINE BOATS.—Number and Description of Each Type.

Type.	No.	Tons.	Lgth.	Bdth.	Motive Power. Afloat.	Motive Power. Under water.	Ext. speed.	Remarks.	No. of Torp. tubes.
BRITAIN, 19.			ft.	ft.					
Holland	5	120	63⅓	11¾	Gasoline	Electricity	8	Ready	1
Holland improved	4	180	100	?	Gasoline	Electricity	14	Three ready	
New programme	10	Details uncertain					15	Improved type of Holland of larger size and greater sea-going power than the above.	
FRANCE, 56.									
Gymnote	1	30	59	6	Electricity		8	Experimental. Launched 1889	0
Gustave Zédé	1	266	159	12⅓	Electricity		8	Can descend 65 feet	1
Morse	1	144	118	9	Electricity		12	One of the most successful submarines. Cost £25,920	1
Narval	1	200	111½	12½	Steam	Electricity	[illegible]1	So called "submersible." Takes 20 minutes to plunge. Can fire torpedoes in all directions.	—
Siluré	4	106	111½	12⅓	Steam	Electricity	12	Submersibles	—
Algerien	2	146	118	9⅙	Electricity		9	Morse type	1
Farfadet	4	185	135½	9½	Electricity		12	Improved Morses	1
Alose	20	68	77	7½	Electricity		8	Improved Gymnotes. Will have surface motors, with accumulators for submerged work.	?
Q. 35	1	168	121½	10½	?		10½	Experimental. Reported to have explosive engines. Two screws.	
Q. 36	1	213	142⅔	9¾	?		11	Experimental. Single screw.	
Q. 37	1	202	135⅔	9⅔	?		11	Experimental. Single screw.	
Omega	1	301	160	13¾	?		11	Experimental. Explosive engines. Largest submarine yet laid down.	2
Q 39-56	18	Details uncertain							
Unnumbered	12	Details uncertain						Six will be of 450 tons, larger than Omega.	
GERMANY, 2.									
Holland	1	?	43	?	Gasoline	Electricity	8	Small experimental boat	1
Holland improved	1	Details unknown					—	Of special type. To be built at Kiel.	
UNITED STATES, 13.									
Holland	1	74	54	10¼	Gasoline		8	Small experimental	1
Adder	7	120	63¾	11¾	Gasoline		8	Similar to British Hollands	1
Experimental	5	Details uncertain							
RUSSIA, 8?									
Peter Kochka	1	20	50	4	Electricity		8	Cigar-shaped sectional submarine boat.	
New type	6?	—	66	12	Gasoline	Electricity	?	To carry crew of twelve. Cigar-shaped	?
ITALY, 4.									
Delfino	1	107	79	9	Electricity		8½	Experimental	2
Tritone	1	—	56	—					
Glauco	1	—	55	—	?		14	Submersible. To have a range of 2,000 knots.	
New boat	1	—	—	—			—	Reported to be an improved Glauco.	
SPAIN, 1.									
Peral	1	87	72	9	Electricity		10	A failure.	

* The details are only approximate. Much secrecy is observed by all the Powers, especially as to design, speed, &c. —"*Daily Mail*" *Year Book*.

SECTIONAL DIAGRAM SHOWING THE INTERIOR OF A JAPANESE TORPEDO BOAT DESTROYER.

t, explosive charge; *k*, cartridge primer; *o*, safety device to check premature explosion; *a*, depth-regulating piston; *e*, rod of swinging pendulum *d*; *i*, compressed air chamber; *f* and *g*, tubes that contain rods connecting depth-regulating device *a*, *e*, *d*, with diving rudders; *l*, bevel gear for causing propellers *m* to rotate in opposite directions; *n*, vertical rudder.

LONGITUDINAL SECTION THROUGH A SCHWARTZKOPFF TORPEDO, A TYPE USED IN THE RUSSIAN NAVY.

THE TORPEDO BOAT IN MODERN WARFARE.

The Russo-Japanese war has proved the wisdom of building torpedo boat destroyers of the dimensions and power that characterize the latest models. With their length of 220 feet, beam of over 20 feet and draft of between 9 and 10 feet, giving a displacement of between 300 and 400 tons, the modern destroyer is a very serviceable sea boat, which was more than could be said for the torpedo boat of an earlier decade. The high freeboard and the provision of a raised turtle-back forward, render these boats able to maintain their high speed in fairly rough water, and in the present operations the flotillas of Japanese destroyers seem to have been perfectly well able to keep the sea in all weather. Evidently the lessons taught by the disasters that happened to some of the high-powered British torpedo boat destroyers, when they were badly wrenched, and in one case actually broken in two in a heavy seaway, have been laid to heart, and the Japanese destroyers which did such good work around Port Arthur are evidently seaworthy vessels.

A surprising feature of torpedo boat service in the Far Eastern struggle is the wide range of duties which were assigned to the destroyers. Scouting work which ordinarily would be given to cruisers from 3,000 to 6,000 tons displacement was satisfactorily carried out by these little 400-ton craft.

By reference to the section diagram on page 77 the reader can obtain a very complete idea of a torpedo boat interior. Forward in the bow is a collision compartment formed by a bulkhead located several feet from the bow. Aft of that is the chain locker, and then the torpedoes, of which half a dozen are carried on a vessel of this character. Since the torpedo boat carries no armor whatever, the torpedoes, the war-heads, and the magazines are placed below the water-line, where they are safe from any except a plunging shot. The torpedoes are stowed with their war-heads containing the guncotton charge unscrewed, the latter being stowed separately, as shown in the engraving. Aft of the war-heads is the forward magazine and a compartment given up to the general ship's stores. On the deck above are the quarters for the crew, which will number between fifty and sixty men in the larger boats.

THE MODERN TORPEDO.

Commenting during the late Spanish war upon the efficiency of the torpedo, we said: "Although torpedo warfare has not yet achieved results at all proportionate to the amount of thought and skill that have been devoted to it, the failure has probably been due more to a lack of opportunity or of efficient handling than to any deficiency in the torpedo itself." The startling events that marked the opening of the Russo-Japan war have established the truth of that statement, for in the hands of an alert, intelligent and daring people, this deadly weapon, in the first half hour of hostilities, so badly crippled two of the finest battleships and one of the best cruisers of the Russian navy that they had to be beached, and a blow was struck at the naval prestige of Russia from which that country will take many years to recover. At the same time, the Port Arthur torpedo attack must be judged at its true value; and, therefore, we must not lose sight of the fact that information is finding its way to the public ear which makes it pretty evident that the Russian ships were not looking for, and were totally unprepared to receive, a torpedo attack. If this is the case, what has been proved is that if the torpedo boat can get unmolested within easy range, the torpedo is fairly sure of its mark—and this we all knew well enough before the war began.

The Whitehead torpedo is undergoing constant development, the latest improvement being the introduction of the gyroscope for the purpose of keeping the torpedo more accurately upon its true course. The latest patterns include this device and are generally of larger diameter and greater length than the earlier types.

We show on the preceding page an illustration of a Schwartzkopff torpedo, which is the type used in the Russian navy. It is merely a modification of the Whitehead and operates upon the same principles.

The torpedo here shown consists of a cigar-shaped body of phosphor-bronze or steel, divided into six separate compartments as follows: (1) The magazine, (2) the secret chamber, (3) the reservoir, (4) the engine compartment, (5) the buoyancy compartment, (6) the bevel-gear chamber.

The magazine contains the explosive charge, which consists of a series of disks of wet guncotton packed snugly together. The cartridge primer, *k*, for exploding the charge, consists of several cylinders of dry guncotton packed in a tube which passes through perforations in the guncotton disks, *t*. The foremost of the six cylinders contains a detonating primer consisting of fulminate of mercury. The small propeller at the extreme point of the torpedo is part of an ingenious safety device for preventing premature explosion in handling. When not in use, the firing pin is held in check by a sleeve; but as soon as the torpedo strikes the water the rotation of the little propellers releases the sleeve and leaves the firing pin ready to strike the detonating primer the moment the torpedo meets an obstruction.

The "secret chamber" is the most ingenious part of this most ingenious piece of mechanism. Its piston, pendulum and springs perform the important work of regulating the horizontal rudders which keep the torpedo at the proper depth. Immediately in front of the secret chamber is a narrow compartment perforated on its walls to allow the outside water to enter. The front wall of the secret chamber carries a piston, *a*, which can move in the direction of the axis of the torpedo. The pressure of the water is resisted by three coiled springs, as shown in the longitudinal section. At a certain predetermined depth, according to the tension on the springs, the springs and water pressure will be in equilibrium; below that depth the piston will be driven in by the water pressure, and above it the springs will push forward the piston. To prevent too sudden oscillation in this action, the piston is connected to the rod, *e*, of a swinging pendulum, *d*. The motion of the piston is communicated by rods, which pass through the hollow stay rods of the air chamber to the horizontal or diving rudders. If the torpedo goes too deep the piston moves back, the pendulum swings forward and the rudders are elevated, the reverse movements taking place if the immersion is not sufficient. When a torpedo dives into the water, the first part of its run is made on a wave line which crosses and recrosses the desired and ultimate level of immersion, the piston and the pendulum gradually bringing the torpedo to a true course. The reservoir forms the central body of the "fish." It is made of forged cast steel and is tested up to seventy atmospheres. A tuyere at its after end feeds the air to the engine. The torpedo is driven by a three-cylinder engine, with cylinders 120 deg. apart, acting on a common crank. The engine is started by means of a valve which is opened by a lever striking a projecting lug on the launching tube, when the torpedo is fired.

The buoyancy chamber is an air-tight compartment, the purpose of which is to afford the proper buoyancy to the torpedo; it carries a piece of lead ballast, by shifting which the trim can be controlled. The two tubes, *f* and *g*, carry the connecting rods for controlling the horizontal diving rudders.

Next comes the bevel-gear chamber, where is located the gear, *l*, for causing the propellers, *m*, to rotate in opposite directions. The after propeller is keyed to the main shaft; the forward propeller is keyed to a sleeve which rotates freely upon the main shaft, and the motion is reversed by means of two bevel-wheel gears which turn on a spindle at right angles to the main shaft. The "tail" consists of a stock with vertical vanes, which act as the vertical rudder, and two frames which carry the horizontal rudders.

The torpedo is fired from a launching tube by the explosion of a small charge of gunpowder behind it. This compresses the air which surrounds the rear half of the torpedo and thrusts it out of the tube without any serious jar.

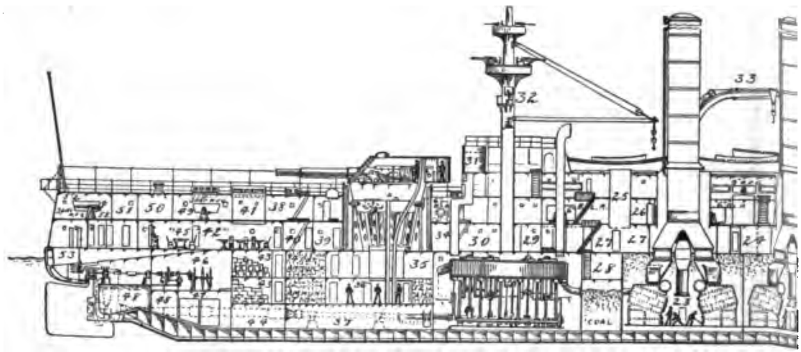
The range and speed of the torpedoes vary with the size. The weapon here shown is 14 inches in diameter, 15 feet in length, carries 90 pounds of guncotton and has a speed of 28 knots for a range of 800 yards. The 18-inch Whitehead torpedo is 16 feet 7½ inches in length, carries a charge of 220 pounds of guncotton and has a speed of 31 knots for 1,000 yards.

INTERIOR OF A BATTLESHIP.

The story of the complicated character of the interior of a modern battleship is one that has grown somewhat stale in the telling, and it is not the fault of the magazine writer and the occasional correspondent of Sunday supplements, if the general public is not satisfied that a great battleship or cruiser is complicated beyond the power of words to express.

In saying that the battleship is complicated we must be careful to remember that complication does not imply confusion; and that in all the practicable achievements of engineering, it would be difficult, if not impossible, to find a structure which, in spite of the many parts of which it is made up and the enormous elaboration of detail that it manifests, is really so harmoniously proportioned, or is better fitted to the ends for which it was designed. There are some subjects of which an illustration will tell more in five minutes than tongue or pen can explain in an hour; and in presenting the accompanying view of the interior of one of the latest battleships of the United States Navy, we shall not attempt to give any elaborate description of the vessel, but will leave it to the diagram to tell its own story.

The drawing is what is known as an inboard profile; that is to say, it is a vertical, central, longitudinal section through the whole length of the ship. The huge structure of which we thus obtain an interior view, is a little under 450 feet in length from the extreme tip of the ram to the end of the rudder. The foundation of the whole is the keel, which is nothing more nor less than a deep plate girder, 3 feet 6 inches in depth, extending from the inboard end of the ram structure to the rudder post. Bisecting it at every 3 feet of its length occurs one of the plate girder frames or ribs, which extend athwartship, and run up to the under edge of the armor shelf, where they are reduced to a depth of say from 18 to 12 inches, the frames extending up the sides of the ship to the level of the upper deck. On the outside of these frames is riveted the outer plating of the ship, and upon the inside of the frames, extending as high up as the under side of the water-line belt, say 4 or 5 feet below the waterline, is riveted an inner shell of plat-



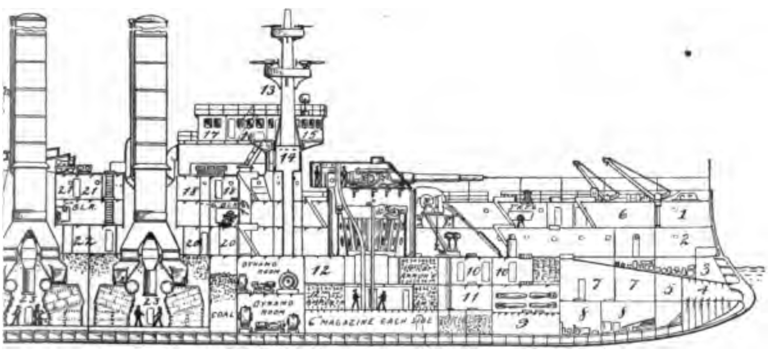
SECTION OF A MODE

1. Crew's showers.
2. Paints and oils.
3. Cofferdam.
4. Trimming tank.
5. Trimming tank.
6. Seamen's lavatory.
7. Bread and dry provisions.
8. Construction stores.
9. Torpedoes and submarine mines.
10. Stores.
11. Hold and cable. Tier each side.
12. Blower room.
13. Military mast.
14. Conning tower.
15. Pilot house.
16. Chart room.
17. Officers' room.
18. Crew's galley.
19. Trunk to dynamos.
20. Wash rooms.
21. Officers' galley.
22. Firemen's room.
23. Boiler room.
24. Firemen's wash room.
25. Trunk to evaporating room.
26. Armory.
27. Evaporator room.

ing. The space between the outer and inner plating is divided up by the frames into transverse water-tight chambers 3 feet in width, and every one of these spaces is subdivided by seven or eight longitudinal plate girders which are built into the double bottom, as it is called, parallel with the keel and extending, most of them, the entire length from stem to stern. Consequently it will be seen that the space between the outer and inner shells of the ship's bottom is divided into an innumerable number of separate compartments, measuring 3 feet in depth by 4 feet in length by about 6 feet in width. The plates are securely riveted together.

Above the inner floor or platform the central portion of the vessel is taken up by the magazines, boiler rooms and engine rooms. These because of their vast importance, are known as the ship's vitals, and great care is taken to provide them against the entrance of heavy projectiles of the enemy, and, as far as may be, against the attack of the still more deadly torpedo. The engines and boilers are so proportioned as to height that they do not extend above the water-line; and to protect them from plunging shot, or from the entrance of the fragments of heavy, high-explosive shells, bursting within the ship above the water-line, a steel deck, 2 to 3 inches in thickness, known as the protective deck, extends at about the level of the water-line over the whole of the vitals, and is continued in a gently curving slope to the ram forward and to the stem aft. In the vessel here shown this steel deck is 1½ inches thick on the flat and 3 inches thick on the slopes.

Now, the space below the protective deck is divided up by a large number of transverse, water-tight bulkheads of steel plating, there being nineteen of these bulkheads altogether. They extend from the inner shell of the vessel to the under side of the protective deck. They are riveted perfectly water-tight, communication from compartment to compartment being by water-tight doors. Forward in the bow are the trimming tanks, used to assist in bringing the vessel to an even keel. Then abaft of the collision bulkhead are bread and dry provision stores, and the construction stores. In the next compartment, which is divided into three decks, we have on the floor of the ship a storeroom for torpedo gear, submarine mines, etc. Above this is



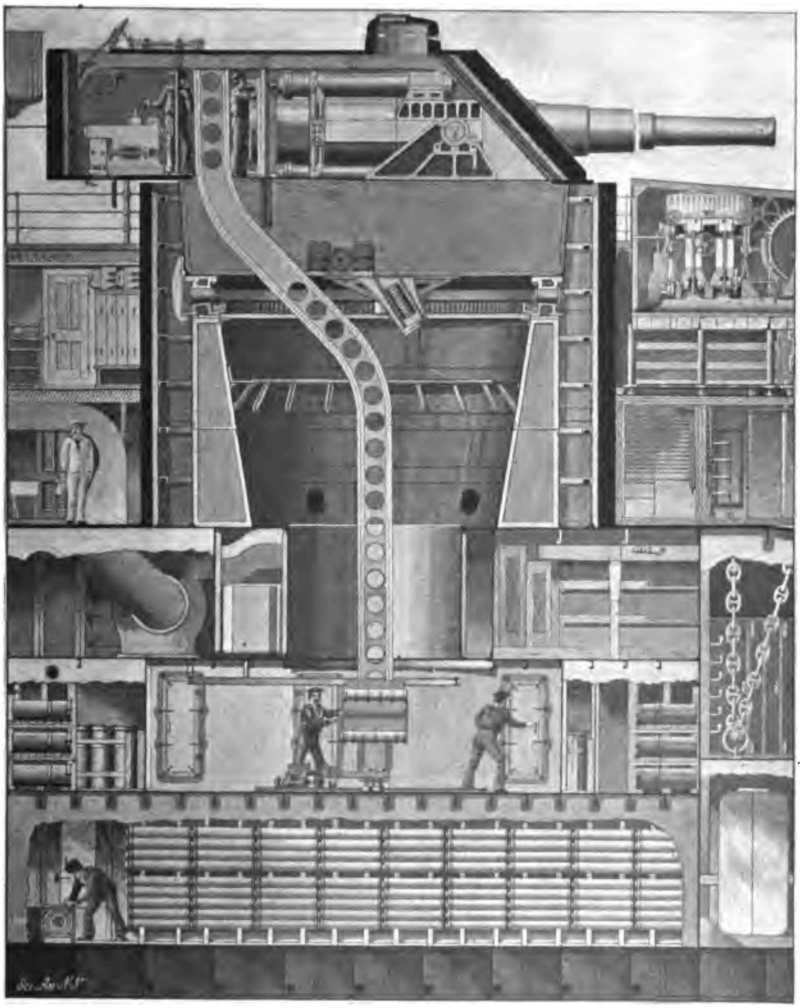
DERN BATTLESHIP.

28. General workshop.
29. Warrant officers' pantry.
30. Warrant officers' dining room.
31. Signal tower.
32. Military mast.
33. Crane.
34. Junior officers' stateroom.
35. Blower room.
36. 12-inch handling room.
37. Shaft alley and 6-inch magazines.
38. Admiral's office.
39. Junior officers' pantry.
40. Wardroom pantry.
41. Skylight trunk to wardroom.
42. Dining room.
43. Stores.
44. Bread and dry provisions.
45. Ward room.
46. Steering machinery room.
47. Fresh water.
48. Trimming tank.
49. Admiral's cabin.
50. Admiral's stateroom.
51. Admiral's lavatory.
52. Admiral's after-cabin.
53. Cofferdam.

the under-water torpedo room, and immediately below the protective deck are kept the paymaster's stores and life preservers. In the next compartment, below on the platform, are the anchor gear and chain lockers, and above this the navigator's stores. Passing through the next bulkhead we come to the vitals of the ship proper, with the 6-inch gun magazines on the floor, the 12-inch magazines and handling rooms on the deck above, and above this the 14-pounder ammunition and blower rooms. Above the magazines, and resting on the protective deck, is the barbette of the forward pair of 12-inch guns, the armor and its relative thickness being shown by heavy, black lines; while in front of the barbette the heavy sloping black line indicates the athwartship sloping bulkhead, placed there to prevent raking projectiles from passing through the entire structure of the ship. Immediately to the rear of the forward barbette is seen the coning tower, with the heavily armored tube which protects the telephones, electric wires, fuse tubes, etc., that pass from the tower down below the protective deck. In the next compartment, aft of the magazines, are the dynamo rooms; and then between the next two bulkheads is placed an athwartship coal bunker. A similar athwartship coal bunker extends athwartship on the other side of the boiler rooms; and it must be understood that at the side of the boiler rooms are the wing bunkers which run aft for the whole length of the boiler rooms and engine rooms. The boiler installation on this particular ship is entirely of the water-tube type, and it consists of twenty-four units arranged in six separate water-tight compartments, three on each side of the center line of the vessel. Aft of the boiler rooms comes the athwartship coal bunker above referred to, and then in two separate water-tight compartments are the twin-screw engines. Aft of the engines in another compartment is contained a complete set of magazines similar to that beneath the forward barbette, and above them, resting on the protective deck is the after barbette and turret, with its pair of 12-inch guns. Aft of the magazines come more compartments, devoted to stores. In the next compartment, down on the platform, are the fresh-water tanks and two trimming tanks, and on the deck above, below the protective deck are, first, the steering-machinery room, and then the steering-gear room, each being in a separate water-tight compartment. This completes the description of the space below the protective deck.

The protective deck is known more generally among seamen as the berth deck. Above that, at a distance of about 8½ feet, comes the main deck, and 8½ feet above that the upper deck, while amidships, between the two main turrets, is the superstructure, the deck of which is known as the superstructure or boat deck. The berth deck and main deck are devoted to the living accommodations of the officers and crew, the crew being amidships and forward, and the officers aft. The berth deck, as its name would indicate, is largely devoted to the berthing and general living accommodation of the crew. Here are also to be found, in the wake of the forward gun turrets, on one side the sick bay, and on the other side the refrigerating room and ice machine. Aft of that, on the port side, are the sick bay, lavatory, dispensary, machinists' quarters, ordnance workshop and blowers; while on the starboard side are the petty officers' quarters, the laundry, and the drying-room. Then, in the wake of the boiler-rooms, on each side of the ship, are coal bunkers which add their protection to that of the side armor of the vessel. In the center of the ship are washrooms for the crew and firemen. Aft of the coal bunkers on this deck come the officers' quarters. On both sides of the ship are the staterooms of the junior officers, and the wardroom staterooms, while between them is a large wardroom and dining-room with its pantry. The extreme aft portion of the berth deck is taken up by officers' lavatories, etc.

On the main deck above, forward, is more berthing accommodation for the crew, also shower baths and lavatories, while amidships are found the various galleys for the crew and the officers, arranged between the basco of the smokestacks, while amidships in the wings of the vessel is more berthing space for the crew. Aft on the main deck the space is given up largely to accommodations for the senior officers and for the admiral, which, by the way, give one an impression more of commodiousness than of rich or extravagant furnishing. Forward. above the conning tower, are the pilothouse, chartroom and the room of the commanding officer. In the particular ship shown, the heavier guns are mounted on the upper deck, two 12-



LONGITUDINAL SECTION THROUGH A UNITED STATES BATTLESHIP SHOWING 12-INCH GUN TURRET, BARBETTE, HANDLING ROOM, AND MAGAZINES.

inch guns in a turret forward and two aft, and eight 8-inch guns in two armored turrets, two on each broadside amidships. The intermediate battery of twelve 6-inch guns is mounted on the main deck, the guns firing through casemates. On this deck are also eight 3-inch guns, four forward and four aft; there are also four 3-inch guns, mounted in broadside on the upper deck, within the superstructure. The new method of emplacing guns on our warships, by which it is possible to swing the guns around until their muzzles are flush with the side of the ship, has the good effect of leaving the side of the ship free from projecting objects when the vessel is in harbor, and of leaving the living spaces of the crew but very slightly obstructed.

SECTION THROUGH THE TURRET AND BARBETTE OF A MODERN BATTLESHIP.

In the foregoing illustration, showing the interior of a turret and barbette on a modern American battle ship, the section has been carried down through the structure of the ship to the keel. It is taken on a vertical plane in the line of the keel and includes enough of the ship in the fore and aft direction to take in the ammunition and handling rooms, and show the methods of storing the shot and shell and powder and the means for bringing it up to the breech of the gun. Commencing at the bottom of the section we have, first, the outside plating of the ship; then about four feet above that is the inside plating, or inner bottom, as it is called. This space is divided laterally by the frames of the ship, which run across the bottom and up the sides to the shelf, upon which the side armor rests. Upon the double bottom, and between that and the first deck above, is a magazine where the ammunition is stored in racks as shown in the illustration, this particular ammunition being for the rapid-fire guns of six-inch calibre. On the deck above and centrally below the turret,* is located the handling room into which open by water-tight doors the magazines, where are stored the powder charges and the shells for the 12-inch guns above. Two decks above we come to the steel protective deck, 2½ to 3 inches in thickness. Upon this deck is erected a great circular structure known as the barbette, whose walls will be from eight to twelve inches in thickness. The barbette is actually a circular steel fort, and it is thick enough and its steel protection hard enough, to break up and keep out the heaviest projectiles of the enemy, except when they are fired at close ranges. At about two-thirds of the height of the barbette is a heavy circular track upon which runs a massive turntable. The framing of this turntable extends to a point slightly above the top edge of the barbette, and upon it is imposed the massive structure of the turret, which is formed, like the barbette, of heavy steel armor carried upon framing, the form of the turret in plan being elliptical. Its front face, which slopes at an angle of about 40 degrees, is pierced with two ports, through which project the two heavy 12-inch guns. The mounting of these guns is carried also upon the turntable and revolves with the turret. From the handling room below a steel elevator track extends up through the barbette and curves back to the rear of the gun; and upon this there travel two ammunition cages which are loaded below upon the handling room floor and carry the projectiles and powder up to the breech of the guns, where it is thrust into the gun by mechanical rammers.

THE SUBMARINE MINE.

Broadly speaking, there are three different kinds of submarine mines. First, observation mines, which are fired from the shore when a ship is known to be in range; second, automatic mines, which are exploded on being struck by a ship, which is the kind with which the Russians claim that the "Petropavlovsk" was sunk; third. electric-contact mines, which on being struck by a passing vessel give notification to an operator on shore, who fires the mine by the throw of a switch.

The accompanying illustrations show a system of electric-contact

ground mines, laid across a channel, with a battery of rapid-fire guns on shore so placed that they command the whole of the mine field, and render it impossible for the small boats of the enemy to attempt to explode the mines before the big battleships and armored cruisers pass over them. The battery is placed rather low down near the water, and above it is a battery of heavy 8 and 10-inch breech-loading rifles mounted either *en barbette*, or on disappearing mounts, while above these, carefully masked by shrubbery, is a firing station, which is connected by cables with the mines in the channel. Sometimes, by preference, the firing station is placed in a massive concrete casemate, which is built into the structure of the fortification. The submarine mines would be laid out in a series of parallel lines, and so spaced that the mines in each line would cover the spaces left in the adjacent lines, with the result that on whatever course a ship might be steering, she would be certain to strike one or more of the mines before she passes over the field. The ground mine, which, as we have said, is usually a hemispherical metal case, contains several hundred pounds of high explosive, and is held in place on the bed of the river or channel by its own weight, sometimes assisted by heavy hooks cast upon the outer shell. Anchored to the mine, and floating above it, at a depth below water that is less than the draft of the enemy's vessels, is a hollow buoyant sphere in which is placed the electric circuit-closer. The second engraving of the two herewith shown represents a section through the floating sphere, and shows the details of a type of circuit-closer which has been very widely used. It consists of a horseshoe magnet, *M*, *M*, within which is hung by a coiled wire a ball, *B*. A silken cord is hung from the top of the magnet, passes down through the ball, and is attached to an armature, *A*. When the vessel strikes the buoy, the ball is thrown to one side, draws aside the silken cord and lifts the armature, *A*. To the poles, *N*, *S*, of the magnet are secured two small magnets, *C*, *C*, one end of the coil wire being connected to line and the other to a contact point, *b*. The armature *A* is secured by a spring to an insulated point, *P*, from which a wire passes through the firing fuse in the ground mine to earth. The other end of the armature carries a contact point

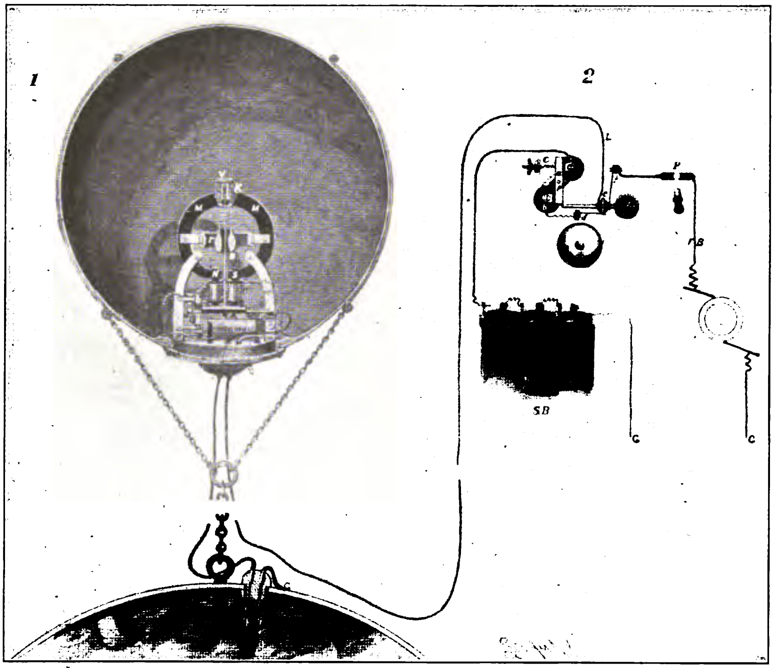
Field of ground mines, showing submerged electric-contact-floating buoys attached. Rapid-fire battery to prevent countermining. Battery of 8 and 10-inch disappearing guns. Firing station and range-finders.

METHOD OF DEFENDING HARBOR CHANNEL WITH SUBMARINE MINES AND BATTERIES OF RAPID-FIRE AND HIGH-POWERED GUNS.

which, when the buoy is struck, engages with a contact point, *b*, which is connected to earth through the interposed resistance of a 1,000-ohm resistance coil.

Our second engraving shows the automatic indicator or shutter, which is placed in the firing station on shore.

Now let us follow more closely the operation of blowing up the hostile magnets, *b*, *b*, and releases the pivoted shutter, 4, ringing the bell and throwing the signal battery line *L* into circuit with the line to the firing battery, *F*, *B*. The operator now places the plug, *P*, in place, and sends the whole force of the main current into the line, and as this has sufficient force to pass the resistance and ignite the fuse, the ground mine is instantly exploded. In



GROUND MINE, ELECTRIC-CONTACT, BUOY, AND SHUTTER AT FIRING STATION.

ship. The instant the vessel strikes the buoy, the suspended ball, *B*, swings to one side, draws aside the cord, pulls up armature *A*, into contact with *b*, and causes the signal-battery current to pass by way of the 1,000-ohm resistance-coil down through the ground fuse to earth. This current is too weak to ignite the fuse. At the same time the armature *a* (in the firing station), is attracted to the the case of an automatic mine of the kind that is claimed to have sunk the "Petropavlovsk," the instant the floating sphere or case is struck by the ship, there is an explosion of the charge, which is carried in the floating case, if the water is very deep, or in the ground mine at the bottom if the water is sufficiently shallow to bring the mine within striking distance of the ship's bottom.

A GROUP OF NAVY PROJECTILES.

The projectiles in use by our navy may be classed as solid shot, shell and shrapnel. Although some excellent solid shot is still manufactured, such as the Johnson fluid compressed shot, solid shot have given place to shell as the standard projectiles of the navy. Shell is formed with an interior cavity of considerable dimensions, in which is placed a charge of powder or high explosive. It is provided with a fuse for the ignition of the charge, which is of the percussion or time-fuse type. The former acts at the instant of striking; the latter is set to explode the shell a certain length of time after the shell has left the muzzle of the gun.

Shrapnel is the modern form of the old case shot, which consisted of a large number of balls put up in a case or envelope, which merely served to hold them together until they left the muzzle of the gun. In the case of shrapnel the envelope is made sufficiently strong to bear the shock of discharge, and a time-fuse is provided.

8-inch 4-inch 10-inch 5-inch 12-inch 6-inch 13-inch

GROUP OF COMMON SHELL AT THE WASHINGTON NAVY YARD.

The best armor-piercing projectiles

are now made of chrome steel, the small admixture of chromium serving to impart to the steel a remarkable amount of toughness. The projectiles are cast, forged, and carefully annealed and tempered, the hardening being confined to the point or nose. The latter is ogival in form, the point being struck with a radius which is two or three times the diameter of the shell. The point has to be sharply pointed to insure its penetration of the hard face of the armor, but if it is made too fine, it will lack the necessary resisting power and will be fractured before it can get through. The best proportion of radius is found to lie between two and three times the diameter.

There are two kinds of armor-piercing projectiles. The first is made solid, or practically so, a small core being formed to give the best results in the forging process; the other type is known as semi-armor-piercing. It is formed hollow, with a core of moderate dimensions, large enough to hold an explosive charge that will insure the bursting of the thick walls of the projectile. It is made of chrome steel, and requires in its manufacture to be treated with great care to secure the combined hardness and toughness to enable it to pierce solid armor without fracturing and carry its explosive charge intact into the interior of the ship. When such shell is filled with common powder the heat engendered by passing through the armor is depended on to explode the shell just within the ship; no fuse is used.

The object at which projectile makers are aiming just now is to make a shell which can carry a charge through the best armor and burst on the inner side of the armor. It is already possible to put solid shot through plate that is as much as one and one-half the diameter of the shot in thickness, and the success of the projectile makers is such as to make it likely that before long a bursting shell can be made to perform the same feat.

It will be evident that penetration of the armor belt by a shell will be vastly more destructive to the ship than penetration by solid shot. The damage wrought by the latter will be confined to its direct path, where the zone of destruction of a shell will be almost as extensive, if it is of the larger calibres, as the whole area of the deck on which it strikes. The effects, moreover, will be greatly augmented if a high-explosive, bursting charge be substituted for common powder, although the sensitiveness of such charges renders it very difficult to carry them through armor plate and burst them on the inside. Excellent results, however, have been achieved in this direction against armor of moderate thickness.

The group of shells shown in our engraving includes one of each of the sizes used on our warships, from the 4-inch 33-pound shell up to the 13-inch 1,100-pound shell of our largest guns. They are all of the class known as "common shell," and are used against fortifications and earthworks and against the unarmored or lightly armored portions of warships. They are usually formed of cast-iron, though sometimes of cast-steel, and the interior cavity is large, enabling a big bursting charge to be carried. Unlike the forged chrome steel shell, they are unfit for armor-piercing, not having the necessary strength to carry them through the plates.

The particulars of these shells are given in the following table:

Diameter.	Length.	Bursting Charge.
4-inch........	1 foot 4 inches.	2 pounds.
5 "	1 " 3 "	3 "
6 "	1 " 9 "	4 "
8 "	2 " 6 "	10 "
10 "	3 " 0 "	22 "
12 "	3 " 8 "	42 "
13 "	4 " 0 "	70 "

It will be noticed that the point of the shell is cut off. It is here that the percussion fuse is inserted. The fuse consists of a hollow threaded brass case, which is screwed into a hole bored through into the interior of the shell. Inside the case is a cylindrical lead plunger, in the center of which is a fulminate and a priming charge. When the gun is fired, the plunger moves to the rear of the fuse, and at the moment when the shell strikes an obstruction it flies forward, the fulminate striking a small anvil on the fuse cap. This ignites the primer, the flame of which enters the shell and explodes it.

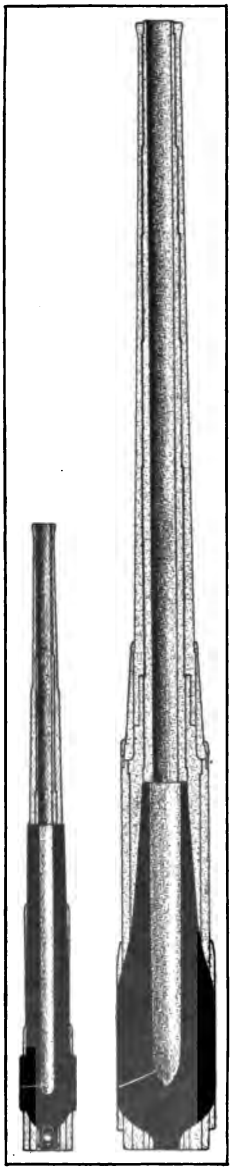
Turkestan is a general government of Central Asia. It comprises the khanates and deserts annexed by Generals Tchernaieff and Kaufmann between 1860 and 1875, and now known as the provinces of Samarcand, Ferghana, and Syr Daria. Area about 257,134 square miles, with 3,900,000 inhabitants.

OUR NAVY GUNS IN THE CIVIL WAR AND TO-DAY.

Naval ordnance has made greater strides in the forty years that have intervened since the Civil War than in several centuries preceding. As proof of this it is enough to look at the striking comparison shown in the accompanying cut. The smaller illustration represents a Parrott 100 pounder of 1862, superimposed upon a modern 100-pounder, or to be correct, a 6-inch 50-calibre rapid-fire rifle of the year 1900; the lower diagram represents a 15-inch smooth-bore of the Civil War, superimposed upon a 12-inch breech-loading 45-calibre rifle of to-day. The comparison might be carried out to greater length throughout all the various calibres that constitute the batteries of naval ships; but we have chosen to compare the main battery of the monitor with the main battery of the modern battleship, and what might be called the secondary battery of the frigates of 1862 with the standard secondary battery gun of the battleship of to-day.

The heaviest piece carried in the Civil War was the 15-inch smooth-bore. This gun weighed 42,000 pounds; its length over all was 15 feet 1 inch; its maximum diameter at the breech was 4 feet, and with an ordinary charge of 35 pounds of black cannon powder, it fired a spherical shell weighing 350 pounds. According to the ordnance regulations, under extraordinary conditions, these guns might be fired 20 rounds "at ironclads at close quarters," using 100 pounds of hexagonal or cubical powder and a solid shot weighing 450 pounds. Under these conditions the most respectable muzzle velocity of 1,600 foot-seconds was obtained, with a corresponding muzzle energy of 7,997 foot-tons. It would be interesting to know what the powder pressure was under these conditions, for the velocity and energy are something truly remarkable for a cast-iron gun. It is little wonder that only 20 rounds were allowed under the severe stresses imposed by these ballistics.

Now, compare these results with the most powerful gun in our navy to-day, namely, the 12-inch 45-calibre rifle, which weighs 53.4 tons, has a total length of 45 feet, and with a charge of 360 pounds of smokeless powder fires an 850-pound shell with a muzzle velocity of 2,800-foot seconds and a muzzle energy of 46,246 foot-tons. The true basis of comparison of the



The Parrott 100-pounder rifle and the 15-inch smooth bore (period of Civil War), compared with the 50-calibre 6-inch and the 45-calibre 12-inch rifles of 1902. Civil War guns are shown in black.

OUR NAVAL GUNS IN THE CIVIL WAR AND TO-DAY.

relative efficiency of the two guns is the amount of energy developed per ton of the weight of the gun, and on this basis we find that the old 15-inch smooth-bore gun when fired with 100 pounds of powder developed 427 foot-tons of energy per ton of gun, as against 872 foot-tons of energy developed by the modern 12-inch rifle.

If we take account of the durability of a gun the advantage will be stronger on the side of the modern piece, for whereas the 15-inch smooth-bore was limited to twenty rounds under the given conditions, the modern 12-inch rifles, judging from the small amount of erosion developed with nitro-cellulose powders, should have a useful life of at least half a thousand rounds. Moreover, it must be remembered that the modern elongated shell will hold its velocity much longer than the old spherical shell of the smooth-bore, and, consequently, the respective muzzle velocities and energies are no criterion of the respective efficiencies of the guns.

The gun of 1862 that answers to the modern secondary battery, 6-inch rifle, is the Parrott muzzle-loading rifle, a cast-iron gun which was strengthened at the breech over the powder chamber by shrinking thereon an iron hoop. The bore of the gun was 6.4 inches. It weighed 4.35 tons, was 12 feet 4 inches in length and with a charge of ten pounds of powder it fired a 100-pound shell with an initial velocity of 1,080 foot-seconds and a muzzle energy of 810 foot-tons. Compare this with the modern 6-inch rifle, which weighs 8.5 tons, is 25 feet in length, and with a charge of 40 pounds of smokeless powder fires a 100-pound shell with an initial velocity of 2,900 feet per second and an initial energy of 5,838 foot-tons.

Compared on the basis of energy per ton of gun, we find that the 100-pounder Parrott muzzle loader developed 186 foot-tons of energy per ton of gun, whereas the modern 6-inch breech-loading rifle develops 784½ foot-tons of energy per ton of gun.

THE PAY OF NAVAL AND MARINE CORPS.

An Admiral receives $13,500 whether on sea duty or on shore duty. The first nine Rear-Admirals receive $7,500 while on sea duty, and $6,375 on shore duty. The second nine receives $5,500 on sea duty and $4,675 on shore duty. A Brigadier-General Commandant of Marine Corps, receives $5,500. The Chiefs of the various Naval Bureaus receive $5,500. Captains of the Navy receive $3,500 while on sea duty and $2,975 while on shore duty. The Judge Advocate General and Colonels, Marine Corps, line and staff, receive $3,500. Commanders of the Navy receive $3,000 while on sea duty, and $2,550 while on shore duty. Lieut.-Colonels, Marine Corps, line and staff, receive $3,000. Lieut.-Commanders of the Navy while on sea duty receive $2,500, and while on shore duty $2,125. Majors of the Marine Corps, line and staff, receive $2.500. Lieutenants of the Navy receive $1,800 while on sea duty and $1,530 while on shore duty. Captains of the Marine Corps, if they are of the line, receive $1,800, and if they are of the staff, $2,000. Lieutenants of the junior grade receive $1,500 while on sea duty and $1.275 while on shore duty. First Lieutenant and leader of the band of the Marine Corps receive $1,500. Ensigns of the Navy receive $1,400 on sea duty and $1,190 on shore duty. Second Lieutenants of the Marine Corps, Chief Boatswains, Chief Gunners, Chief Carpenters and Chief Sailmakers receive $1,400. Midshipmen in other than practice ships receives $950. At the Naval Academy and elsewhere $500. Chaplains receive $2,500 on sea duty, $2,000 on shore, and $1,900 on leave or waiting orders. Professors of Mathematics and Civil Engineers receive $2,400 and $1,500 when on leave of absence or waiting orders. Naval Constructors receive $3,200, and while on leave of absence or waiting orders, $2,200. Assistant Naval Constructors receive $2,000, and $1,500 while on leave or waiting orders. The warrant officers, boatswains, gunners, carpenters, sailmakers, pharmacists and warrant machinists receive $1,200 while on sea duty and $900 while on shore, $700 on leave of absence or waiting orders. Mates who were in service August 1, 1904, receive $1,200 for sea duty, $900 for shore duty, $700 on leave. Those appointed since receive $900, $700 and $500 respectively. The monthly pay of petty officers and enlisted men is: Chief petty officers, $50 to $70; petty officers, first-class, $36 to $65; petty officers, second-class, $35 to $40; third-class petty officers, $30; first-class seamen, $21 to $35; second-class seamen, $15 to $30; third-class seamen, $9 to $22.

CHAPTER IV.

THE ARMY OF THE UNITED STATES.

Twice in the history of the world we have had an example of large bodies of men who were not producers who disturbed economic conditions by living at the public expense. We refer to the enormous monasteries in the middle ages and to the standing armies in Europe to-day. It seems to be essential to the maintenance of the integrity of a number of the countries of Europe to keep a large standing army—an army which takes some of the best years of the life of its citizens, as service is obligatory to all. These armies are supported at an enormous expense by systems of taxation which affect the poorest as well as the richest.

The question of the standing armies of Europe is a problem which is rapidly increasing in seriousness, and there does not appear as yet to be any solution of the difficulty.

For our protection we have to rely upon:

1. The Regular Army, which represents and is under the pay of the federal government, and which is officered: 1. By graduates of the United States Military Academy, who at present are largely in the minority. 2. By the promotion of meritorious enlisted men of the Army. 3. By the appointment of civilians, six of whom are annually selected from the best cadet-schools of the country. The last class is at present most largely represented.

The officers receive commissions at the hands of the President.

2. The organized militia or National Guard, which is composed exclusively of State troops, and, except when called into the service of the United States, is under the command of the Governors of the respective States. The officers of higher grade are appointed by the Governors, but the other officers, from Colonel down, are generally selected by ballot by the troops themselves. The National Guard is intended primarily for home defense.

3. The Volunteers, which form a branch of the service only to be found in time of war. They are such as offer their services upon the call of the President, and are officered either by West Point graduates, by officers of the National Guard, or civilian appointees.

Under the conditions existing in the late war with Spain, members of the National Guard were not called upon to serve in their capacity as State troops, but were invited to enlist in the volunteer service.

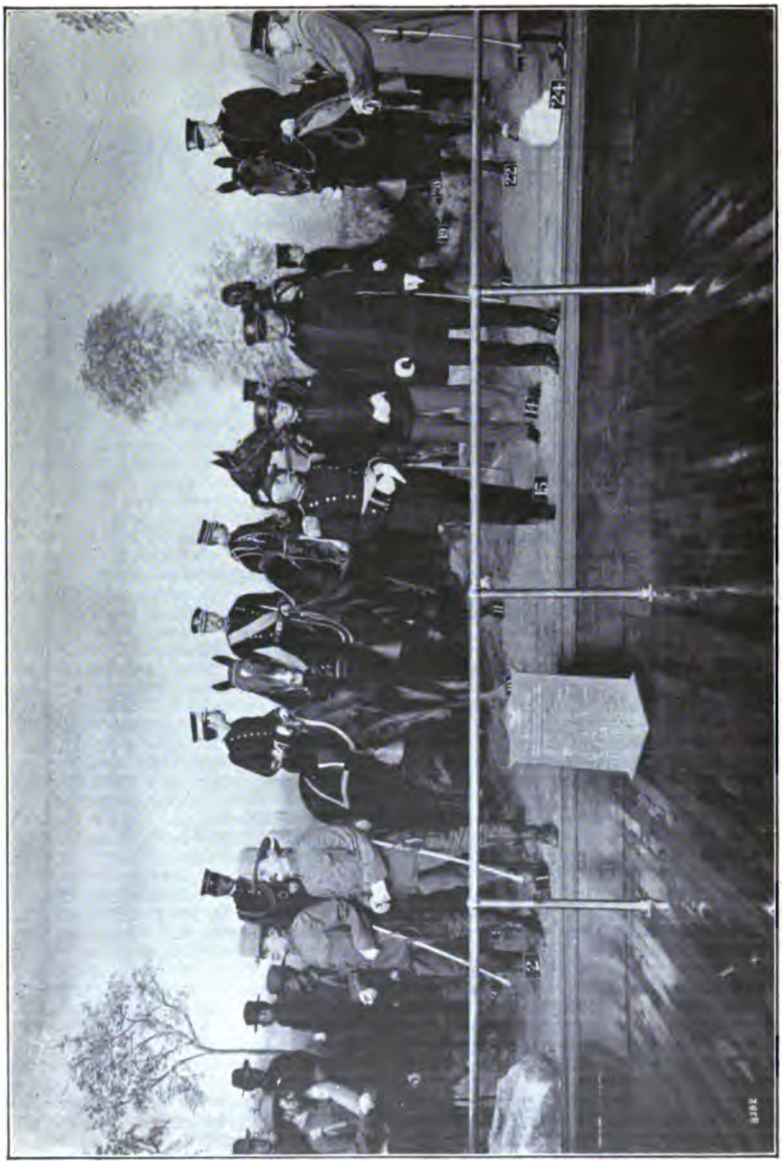
The term of enlistment in the regular service is for a period of three years, which term is fixed and not terminable by the ending of the war. In the volunteer service the period of enlistment is two years, but this term may be shortened by the ending of hostilities.

A certain proportion of the officers of the regular army are graduates of the United States Military Academy at West Point, New York.

By Acts of Congress approved June 6, 1900, June 28, 1902, and March 3, 1903, the Corps of Cadets as now constituted consists of one from each Congressional district, one from each Territory, one from the District of Columbia, one from Porto Rico, two from each State at large, and forty from the United States at large, all to be appointed by the President and, with the exception of the forty appointed from the United States at large, to be actual residents of the Congressional or Territorial districts, or of the District of Columbia, or of the States, respectively, from which they are appointed. Under these Acts, and under the apportionment of Members of Congress according to the 12th Census, the maximum number of cadets is 522.

The total number of graduates from 1802 to 1903, inclusive, is 4,214; 124 members graduated June 15, 1904.

Foreign governments can have cadets educated at the academy by authorization of Congress.



GROUP OF OFFICERS AND MEN OF THE UNITED STATES ARMY, SHOWING UNIFORMS.

GROUP OF OFFICERS AND MEN SHOWING UNIFORMS WORN IN UNITED STATES ARMY.

1. Major of Engineers in olive-drab uniform.
2. Captain of Ordnance in olive-drab uniform.
3. Private of Cavalry in olive-drab uniform.
4. First Sergeant of Artillery in olive-drab uniform.
5. Private of Infantry in olive-drab uniform and clothing roll.
6. First Sergeant of Cavalry in olive-drab uniform.
7. Corporal of Post Artillery in olive-drab uniform and overcoat.
8. Post Quartermaster-Sergeant in olive-drab uniform.
9. Trumpeter of Cavalry, mounted, in full-dress uniform.
10. Colonel of Infantry, mounted, in full-dress uniform.
11. Major-General, mounted, in full-dress uniform.
12. Lieutenant-Colonel of Artillery, Aide-de-Camp, mounted, in full-dress uniform.
13. First Sergeant of Infantry, in full-dress uniform.
14. Captain of Cavalry, dismounted, in full-dress uniform.
15. Brigadier-General, dismounted, in dress uniform.
16. Major, Medical Department, dismounted, dress uniform and cape.
17. Corporal of Engineers, full-dress uniform.
18. Private of Cavalry, full-dress uniform.
19. Sergeant of Artillery in full-dress uniform.
20. Post Commissary-Sergeant, dress uniform.
21. Lieutenant of Cadets, U. S. Military Academy, full-dress uniform.
22. Major, Quartermaster's Department, in full-dress uniform.
23. First-class Sergeant, Signal Corps, in full-dress uniform.
24. Captain Coast Artillery, in dress uniform and overcoat.

The commander-in-chief is, ex-officio, of course, the President of the United States.

Like the grades of Admiral and Vice-Admiral, the army also has two grades—General and Lieutenant-General. We have had only four Generals, Washington, Grant, Sherman and Sheridan. A general is supposed to command an army. An army is a large and organized body of soldiers generally composed of infantry, artillery and cavalry, completely armed and provided with necessary stores, etc., and the entire force is under the direction of one general, who is called the "general-in-chief." The army is subdivided as follows; the grades of rank and commands appropriate to each grade are given.

An "army" is divided into two or more corps commanded by a Major-General. A "corps" is "the largest tactical unit of a large army. A corps is usually organized with separate staff, infantry, cavalry, and artillery regiments, as well as auxiliary services, so that it is really a small army complete in itself. A corps is usually composed of three divisions, each commanded by a Major-General or a Brigadier-General. A "corps" is also any body or department of an army which is not detached, but has its own organization and head, as the "Corps of Engineers." Each "division" is composed of three brigades, and there may be an independent brigade of cavalry or artillery called the divisional cavalry or artillery.

A "brigade" consists of three regiments, though there may be more, and it is commanded by a Brigadier-General, and sometimes by a Colonel. A "regiment," which is the administrative unit, is commanded by a Colonel, and it is divided into twelve companies, each composed, under the present law, of a maximum of 150 men for the infantry, 100 men for the cavalry, a total of 18,920 for the artillery corps, and 150 men for the engineers. A "company" is commanded by a Captain. Two or more companies form a "battalion," and the battalion is commanded by a Major.

The relative rank between the officers of the army and navy is as follows: General with Admiral; Lieutenant-General with Vice-Admiral; Major-General with Rear-Admiral; Brigadier-General with Commodore; Colonel with Captain; Lieutenant-Colonel with Commander; Major with Lieutenant-Commander; Captain with Lieutenant; First Lieutenant with Lieutenant (junior grade); Second Lieutenant with Ensign.

The pay of the officers in active service is as follows: Lieutenant-General, $11,000; Major-General, $7,500; Brigadier-General, $5,500; Colonel, $3,500; Lieutenant-Colonel, $3,000; Major, $2,500; Mounted Captain, $2,000; Captain on foot, $1,800; regimental Adjutant, $1,800; regimental Quar-

termaster, $1,800; First Lieutenant, mounted, $1,600; First Lieutenant on foot, $1,500; Second Lieutenant, mounted, $1,500; Second Lieutenant on foot, $1,400. All of the officers from the Colonel down receive additional amounts after five, ten, fifteen and twenty years' service, but there is a limit to this amount; thus the maximum pay of a Colonel is $4,500 per annum. The pay of a private, whether artillery, cavalry or infantry, is $13 per month for the first and second years, $14 for the third year, $15 for the fourth year, $16 for the fifth year. After five years' continuous service they receive $2 per month extra. For service in the insular possessions 20 per cent. is added to the pay of officers and enlisted men.

The present strength of the regular army is about 3,800 officers and 60,000 enlisted men; 13,000 of them are in the Philippines. This does not include 4,800 scouts, who are paid from the Philippine treasury proper.

The policy of the United States in having a small military establishment has led to the organization of a large body of reserves, which are known as the organized militia or "National Guard." According to the latest accounts received at the office of the Adjutant-General in 1903 there were in the National Guard of the various States and Territories 9,184 commissioned officers and 107,422 non-commissioned officers, privates, musicians, etc., making a total of 116,606.

Under the Act of Congress approved January 31, 1903, the militia consists of every able-bodied male citizen of the United States who is more than eighteen and less than forty-five years of age, and is divided into two classes—the organized militia or National Guard, and the remainder to be known as the reserve militia. It is entirely optional whether eligible citizens join the National Guard or not, and they elect their own officers, but it is safe to say that this body of reserves is recruited from the best and most patriotic element of the population of the United States. Congress makes an appropriation each year for the support of the militia in the various States, and the States also contribute, help and build armories, as the regiments are really intended to defend their own States primarily, although in time of war they furnish an excellently drilled body of volunteers. In nearly every city of any great size there is one or more armories, and in the smaller cities and towns there are separate companies which have armories or drill halls. The militia in each State is divided into brigades, regiments and companies. Under the act of Congress above named the President of the United States has the power to call upon any of the military organizations of the States for national defense, but the troops are usually utilized by the Governor of the State for enforcing the State laws.

The experience of the Spanish-American war demonstrated the need of what is known in foreign armies as a General Staff Corps. Accordingly, under the Act of Congress approved February 14, 1903, a Chief of Staff was authorized, to take the place of the commanding general of the army, and a General Staff Corps whose duties are defined as follows: To prepare plans for the national defense and for the mobilization of the military forces in time of war; to investigate and report upon all questions affecting the efficiency of the army and its state of preparation for military operations; to render professional aid and assistance to the Secretary of War and to general officers and other superior commanders, and to act as their agents in informing and co-ordinating the action of the different officers who, under the terms of the act, are subject to the supervision of the Chief of Staff; and to perform such other military duties not otherwise assigned by law, as may from time to time be prescribed by the President.

Under this act a number of officers were detailed in the General Staff for a period of four years, and the corps was organized into three divisions, each under a superior officer, with the following duties: The first division has charge of army administration, discipline, drill, and equipment; the second division is the division of military information, and in addition has charge of military maps, military attaches and the War Department library: the third division is termed the technical division, and includes the devising of plans for defense and offense, the matter of sites for fortifications, the question of military education, and the Army War College.

This article has been revised by Captain C. D. Rhodes, U. S. A., of the General Staff Corps, under the direction of Major W. D. Beach, U. S. A., Chief of Staff, Second Division.

INFORMATION RELATIVE TO THE APPOINTMENT AND ADMISSION OF CADETS TO THE UNITED STATES MILITARY ACADEMY.

APPOINTMENTS.

How Made.—Each Congressional District and Territory—the District of Columbia and also Porto Rico—is entitled to have one Cadet at the Academy. Each State is also entitled to have two Cadets from the State at large, and forty are allowed from the United States at large. The appointment from a Congressional District is made upon the recommendation of the Congressman from that district, and those from a State at large upon the recommendations of the Senators of the State. Similarly the appointment from a Territory is made upon the recommendation of the Delegate in Congress. Each person appointed must be an actual resident of the State, District or Territory from which the appointment is made.

The appointments from the United States at large, from the District of Columbia and from Porto Rico are made by the President of the United States upon his own selection. The appointment of the Cadet from Porto Rico is made by the President on the recommendation of the Resident Commissioner.

Manner of Making Applications.—Applications may be made at any time, by letter to the Adjutant General, U. S. Army, Washington, D. C., to have the name of the applicant placed upon the register that it may be furnished to the proper Senator, Representative, or Delegate, when a vacancy occurs. The application must exhibit the full name, date of birth, and permanent abode of the applicant, with the number of the Congressional District in which his residence is situated.

Date of Appointments.—Appointments are required by law to be made one year in advance of the date of admission, except in cases where, by reason of death or other cause, a vacancy occurs which cannot be provided for by such appointment in advance. These vacancies are filled in time for the next examination.

Alternates.—For each candidate appointed there may be nominated *two alternates*. The principal and each alternate will receive from the War Department a letter of appointment, and must appear for examination at the time and place therein designated; those previously accepted by Academic Board on certificate or mentally qualified, appearing for physical examination only.

The fitness for admission to the Academy of the principal and the alternates will be determined as prescribed in paragraphs 19, 20 and 21, Regulations U. S. Military Academy.

Should the principal and alternates not qualify for admission under the provisions of paragraph 21, they will still be entitled to appear for the examination prescribed in paragraph 19; but if the principal fails to appear for that examination or, appearing, fails to qualify, then the qualifications of the alternates will be considered and if only one has met the requirements he will be admitted; if both alternates have met the requirements the better qualified will be admitted.

The alternates, like the principal, should be designated as nearly one year in advance of the date of admission as possible.

ADMISSION OF CANDIDATES.

The following are extracts from the regulations of the Military Academy relating to the examination of candidates for admission and will be strictly adhered to:

19. Candidates selected for appointment, unless accepted under the provisions of paragraph 21, shall appear for mental and physical examination before boards of army officers to be convened at such places as the War Department may select, on the first of May, annually, except when that day comes on Sunday, in which case the examination shall commence on the following Tuesday. Candidates who pass successfully will be admitted to the Academy without further examination upon reporting in person to the Superintendent at West Point before 12 o'clock noon on the 15th day of June of the same year.

20. Each candidate before he shall be admitted to the Academy as a Cadet must show, by the examination provided for in paragraph 19 or by the methods prescribed in paragraph 21,

that he is well versed in the following prescribed subjects, viz.: Reading, writing, spelling, English grammar, English composition, English literature, arithmetic, algebra through quadratic equations, plane geometry, descriptive geography, and the elements of physical geography, especially the geography of the United States, United States history, the outlines of general history, and the general principles of physiology and hygiene.

21. The Academic Board will consider and may accept in lieu of the regular mental entrance examination:

1st. The properly attested examination papers of a candidate who receives his appointment through a public competitive written examination covering the range of subjects prescribed in paragraph 20.

2d. The properly attested certificate of graduation from a public high school or a State normal school in which the course of study, together with the requirements for entrance, shall cover the range of subjects prescribed in paragraph 20.

3d. A properly attested certificate that the candidate is a regular student of any incorporated college or university, without condition as to any subject mentioned in paragraph 20.

Application for consideration of papers or certificates shall be made by each candidate and alternate immediately after he receives his appointment. No application will be received after March 15 preceding the regular examination prescribed in paragraph 19.

Candidates accepted as qualified mentally under the provisions of this paragraph shall appear for physical examination at the time and place designated in their letters of appointment.

Immediately after reporting to the Superintendent for admission, and before receiving his warrant of appointment, the candidate is required to sign an engagement for service in the following form, and in the presence of the Superintendent, or of some officer deputed by him:

"I, —— ——, of the State (or Territory) of ——, aged —— years —— months, do hereby engage (with the consent of my parent or guardian) that, from the date of my admission as a Cadet of the United States Military Academy, I will serve in the Army of the United States for eight years, unless sooner discharged by competent authority.

"In the presence of —— ——."

The candidate is then required to take and subscribe an oath or affirmation in the following form:

"I, —— ——, do solemnly swear that I will support the Constitution of the United States, and bear true allegiance to the National Government; that I will maintain and defend the sovereignty of the United States, paramount to any and all allegiance, sovereignty, or fealty I may owe to any State or country whatsoever; and that I will at all times obey the legal orders of my superior officers, and the rules and articles governing the Armies of the United States.

"Sworn and subscribed, at ——, this —— day of —— nineteen hundred and —— before me.

—— ——."

Qualifications.—No candidate shall be admitted who is under seventeen, or over twenty-two years of age, or who is deformed, or afflicted with any disease or infirmity which would render him unfit for the military service, or who has, at the time of presenting himself, any disorder of an infectious or immoral character. Accepted candidates if between seventeen and eighteen years of age should not fall below five feet three inches in height and one hundred pounds in weight; if between eighteen and nineteen years, five feet three and one-half inches in height and one hundred and five pounds in weight; if over nineteen, five feet four inches in height and one hundred and ten pounds in weight. Candidates must be unmarried.

Each candidate must on reporting at West Point present a certificate showing successful vaccination within one year; or a certificate of two vaccinations, made at least a month apart, within three months.

A circular of information as to the physical and mental examination can be had by addressing the Secretary of War, Washington, D. C.

ACADEMIC DUTIES.

The academic duties and exercises commence on the first of September and continue until the first of June.

Examinations of the several classes are held in December and June, and, at the former, such of the new Cadets as are found proficient in studies and have been correct in conduct are given the particular standing in their class to which their merits entitle them. After each examination, Cadets found deficient in conduct or studies are discharged from the Academy, unless the Academic Board for special reasons in each case should otherwise recommend. Similar examinations are held every December and June during the four years comprising the course of study.

Military Instruction.—From the termination of the examination in June to the end of August the Cadets live in camp, engaged only in military duties and exercises and receiving practical military instruction.

Except in extreme cases, Cadets are allowed but one leave of absence during the four years' course; as a rule the leave is granted at the end of the first two years' course of study.

PAY OF CADETS.

The pay of a Cadet is $500 per year and one ration per day, or commutation therefor at thirty cents per day. The total is $609.50, to commence with his admission to the Academy. The actual and necessary traveling expenses of candidates from their homes to the Military Academy are credited to their accounts *after* their admission as Cadets. There is no provision for paying the expenses of candidates who fail to enter and they must be prepared to defray all their own expenses.

No Cadet is permitted to receive money, or any other supplies, from his parents, or from any person whomsoever, without the sanction of the Superintendent. A *most rigid* observance of this regulation is urged upon all parents and guardians, as its violations would make distinctions between Cadets which it is the especial desire to avoid; the pay of a Cadet is sufficient, with proper economy, for his support.

Each Cadet must keep himself supplied with the following mentioned articles, viz.:

Two pairs of uniform shoes: six pairs of uniform white gloves; two sets of white belts; *eight white shirts; *four night shirts: twelve white linen collars; twelve pairs of white linen cuffs; *eight pairs of socks; *eight pairs of summer drawers; *six pairs of winter drawers; *twelve pocket handkerchiefs; *twelve towels; two clothes bags, made of ticking; *one clothes brush; *one hair-brush; *one tooth brush; *one comb; one mattress; one pillow; four pillow-cases; eight sheets, two blankets, and one quilted bed cover; one chair; one tumbler; *one trunk; one account book; one wash basin.

Candidates are authorized to bring with them the articles marked *.

Cadets are required to wear the prescribed uniform. All articles of their uniform are of a designated pattern, and are sold to Cadets at West Point at regulated prices.

DEPOSIT PRIOR TO ADMISSION.

Immediately after being admitted to the Institution, Cadets must be provided with an outfit of uniform, the cost of which will be about $100, *which sum must be deposited with the Treasurer of the Academy before the candidate is admitted.* It is best for a candidate to take with him no more money than will defray his traveling expenses, and for the parent or guardian to send to "*The Treasurer of the U. S. Military Academy*," the required deposit of $100. This amount is sufficient to equip a new Cadet with uniform and to supply him with all articles and books.

PROMOTION AFTER GRADUATION.

The attention of applicants and candidates is called to the following provisions of an Act of Congress approved May 17, 1886, to regulate the promotion of graduates of the United States Military Academy:—

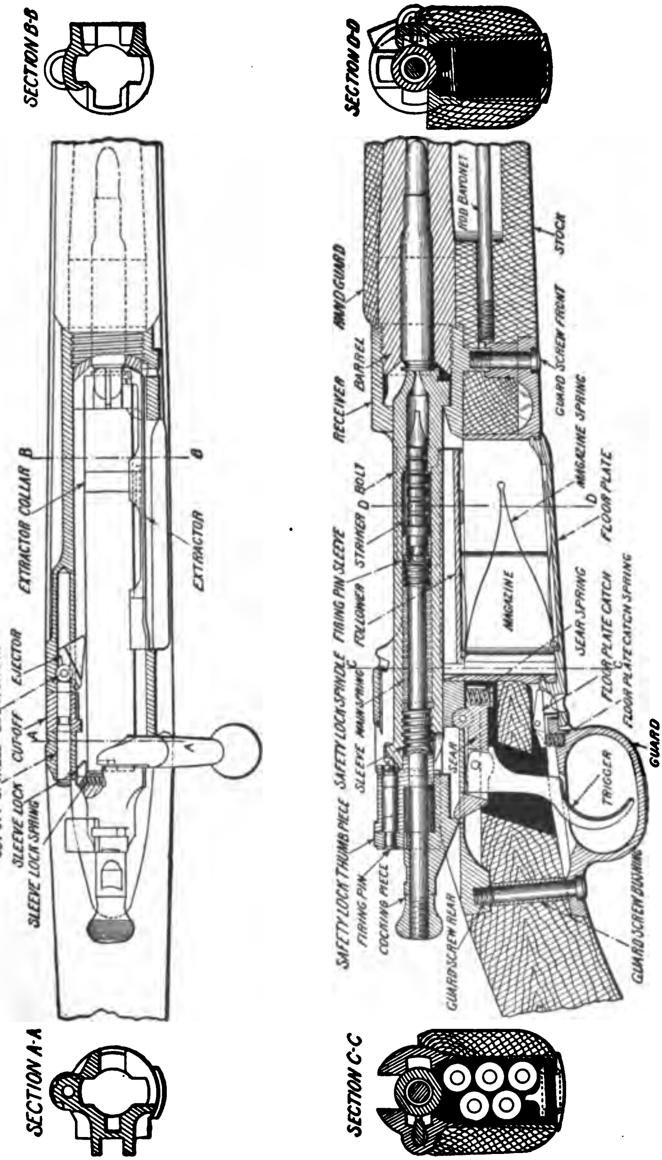
"That when any Cadet of the United States Military Academy has gone through all its classes and received a regular diploma from the Academic Staff, he may be promoted and commissioned as a second lieutenant in any arm or corps of the army in which there may be a vacancy and the duties of which he may have been judged competent to perform; and in case there shall not at the time be a vacancy in such arm or corps, he may, at the discretion of the President, be promoted and commissioned in it as an additional second lieutenant, with the usual pay and allowances of a second lieutenant, until a vacancy shall happen."

THE NEW SPRINGFIELD MAGAZINE RIFLE.

THE NEW SPRINGFIELD ARMY RIFLE.

Muzzle velocity, 2,300 feet per second. Weight of bullet, 220 grains. Weight of charge, 43.3 grains. Weight of gun including bayonet and scabbard, 9.47 pounds.

The new Springfield magazine rifle, which has undergone its preliminary tests with very gratifying results, will take the place of the Krag-Jorgensen, which now, for several years, has been doing excellent service in the United States Army. We present a photograph of the gun, which will be known as Springfield Magazine Rifle Model 1902, and also a line-drawing which shows several sectional views of the gun. By means of the carefully lettered parts a good idea is obtained of the details of the gun. The weapon is supplied with a cleaning rod, which can be partially pulled from its place below the barrel, and held with a catch so as to form a bayonet. The great advantage of the rod bayonet is that it lightens the weight made up of the gun, bayonet and bayonet's scabbard, and, by dispensing with the latter two as separate articles to carry, permits the soldier to carry with him an entrenching tool of sufficient size and weight to be serviceable. While there is some diversity of opinion as to the value of the rod bayonet, which is considered to be less effective than the type now in use, it still is of value as converting the musket into a pike. Moreover, in view of the growing value of the entrenching tool and the ever-decreasing opportunities for the use of the bayonet, the substitution of an entrenching tool for the latter is certainly in line with the recent development of field operations. The piece is centrally fed by means of clips, each of which holds five cartridges; and it will be noticed that the bolt has two lugs instead of one as in the old gun. In a recent report of the Chief of Ordnance the trials of the piece are spoken of as having given "very satisfactory results." The chief points of difference from the Krag-Jorgensen are this use of two lugs in place of one for holding the bolt against the rearward pressure of the powder—the increased strength so obtained being sufficient to allow of an increase of velocity with the same weight of bullet, from 2,000 feet per second in the Krag-Jorgensen to 2,300 feet per second in the new piece, the resulting increase in muzzle energy being from 1,952 foot-pounds to 2,582 foot-pounds. The Krag-Jorgensen is capable of penetrating 45.8 inches of white pine at a distance of 53 feet, whereas the new weapon penetrates 54.7 inches at the same distance. The striking energy at 1,000 yards has been



DETAILS OF THE NEW SPRINGFIELD ARMY RIFLE.

raised from 396 foot-pounds to 448. Other data regarding the new piece are as follows: The caliber is 0.30; the rifling is made up of four grooves of a depth of 0.004 inch, the twist being one turn in 10 inches. The bullet weighs 220 grains, which is the same as that of the Krag-Jorgensen, but the powder charge has been raised from 37.6 to 43.3 grains. In spite of the considerable increase in its power the weapon has been greatly reduced in weight; for while the present service magazine rifle weighs 10.64 pounds, and the Mauser 10.5 pounds, and the German military rifle 11.54 pounds, the new weapon weighs only 9.47 pounds. It follows, as a matter of course, that, with such high velocity and fairly heavy bullet, the trajectory is correspondingly flat, the maximum ordinate of the 1,000 yard trajectory being only 20.67 feet as against 25.8 feet for the Krag-Jorgensen, 24.47 for the Mauser and 23.73 for the German military rifle.

In addition to those mentioned above there are other improvements, such as housing of the magazine in the stock directly below the chamber, instead of having it project at the side of the gun, and there are many changes of detail which both improve the rifle and cheapen and accelerate its production.

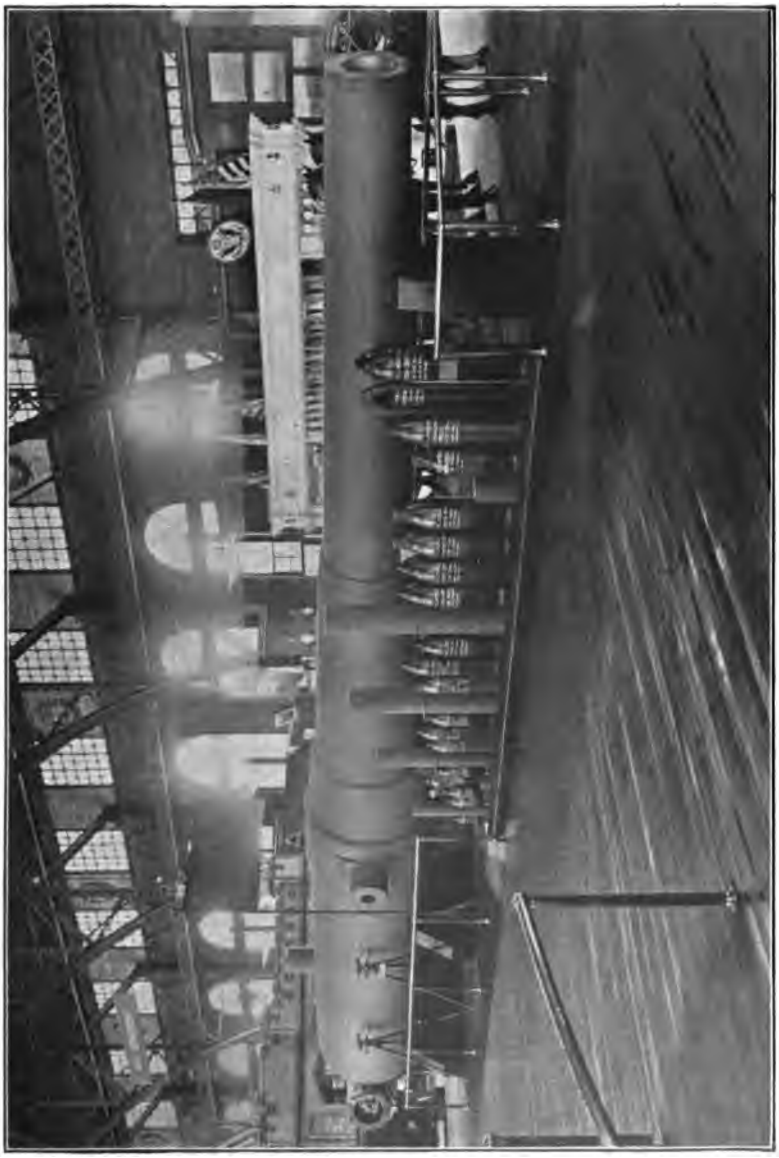
In closing it should be mentioned that the new gun is considerably shorter than any existing rifle, and is only slightly longer than the military carbine.

NEW SPRINGFIELD MAGAZINE RIFLE COMPARED WITH THE KRAG-JORGENSEN, THE MAUSER AND THE GERMAN MILITARY RIFLE.

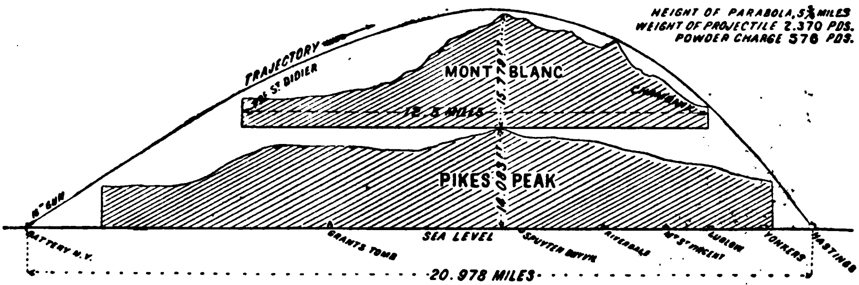
Data.	Springfield Magazine Rifle.	Service Magazine Rifle.	Mauser 7 Mm. Rifle.	German Military Rifle.
Caliber....inch..	0.30	0.30	0.275	0.311
Rifling:				
Number of grooves....	4	4	4	4
Depth of grooves....inch..	0.004	0.004	0.0049	0.004
Twist, one turn in....inches..	10	10	8.66	9.45
Weight of bullet....grains..	220	220	173	226.82
Weight of charge....grains..	43.3	37.6	38.58	41.2
Weight of complete cartridge....grains..	451.15	438.85	385.63	430.24
Initial velocity, feet per second....	2300	2000	2200	2145
Remaining velocity at 1,000 yards....	958	901	895	906
Muzzle energy....foot-pounds..	2581.6	1952	1857.4	2135
Striking energy at 1,000 yards. .foot-pounds..	447.9	396.2	307.4	413
Penetration in white pine at 53 feet..inches..	54.7	45.8	50.8	....
Weight of rifle, including bayonet and scabbard....pounds..	9.47	10.64	10.5	11.54
Weight of rifle, including bayonet, scabbard, and 100 cartridges....pounds..	15.91	16.91	16.18	17.68
Capacity of magazine....rounds..	5	5	5	5
Maximum ordinate of 1000 yd. trajectory, feet..	20.67	25.8	24.47	23.73

THE SIXTEEN-INCH GUN.

The great 16-inch 126-ton gun. built for the United States at the Watervliet arsenal, is 49¼ feet long, over 6 feet in diameter at the breech, and it has an extreme range of over twenty miles. Its projectile weighs 2,370 pounds, and costs $865 to fire the gun once. The map on page 102 will give graphic illustration of the range of this gun. If fired at its maximum elevation from the battery at the south end of New York in a northerly direction, its projectile would pass over the city of New York, over Grant's Tomb, Spuyten Duyvil, Riverdale, Mount St. Vincent, Ludlow, Yonkers, and would land near Hastings-on-the-Hudson, nearly twenty miles away, as shown in our map. The extreme height of its trajectory would be 30,516 feet, or nearly six miles. This means that if Pike's Peak, of the Western Hemisphere, had piled on top of it Mont Blanc, of the Eastern Hemisphere, this gun would hurl its enormous projectile so high above them both as to still leave space below its curve to build Washington's Monument on top of Mont Blanc, as shown. The model, page 101, was exhibited at St. Louis.

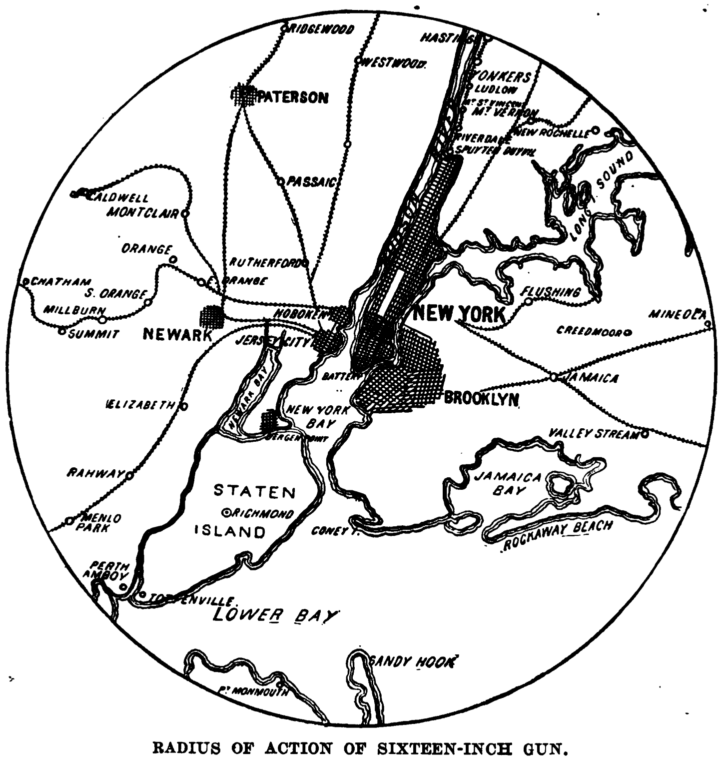


MODEL OF THE 16-INCH GUN, EXHIBITED AT THE LOUISIANA PURCHASE EXPOSITION, ST. LOUIS, 1904.



RANGE OF SIXTEEN-INCH GUN.

Height of parabola, 5¾ miles. Weight of projectile, 2,370 pounds. Powder charge, 576 pounds.



RADIUS OF ACTION OF SIXTEEN-INCH GUN.

ARMIES OF THE LEADING POWERS.

Information on the above points concerning the Armies of Leading Powers is given in the following table.

Nation.	System.	Peace Footing.	†War Footing.	Guns (Approximate Number).	Term of Service or Liability. Years.*	Total.
Austria	Compulsory Service	374,148	2,580,000	1,912	3 A + 7 R + 2 L‡ + 10 L‖	22
Belgium	Conscription and Voluntary	51,644	143,000	204	8 A + 5 R.	13
Bulgaria	Compulsory Service	57,720	205,000	462	2 or 3 A + 8 or 6 R + 7 L‡ + 8 or 9 L‖	25
China	Enlistment	About 100,000 trained men.			?	—
Denmark	Compulsory Service	9,769	61,580	96	½ or 1¼ A + 7½ or 6¾ R + 8 L‡	16
France	Compulsory Service	590,514	3,500,000	3,720	3 A + 10 R + 6 L‡ + 6 L‖	25
Great Britain	Voluntary	274,074	‡420,000	1,194	7 or 8 A + 5 or 4 R, 3A + 9 R.	12
India	Voluntary	146,645	222,219	336	From 3 years upward for natives.	—
Germany	Compulsory Service	605,975	4,000,000	4,524	2 or 3 A + 4 R + 5 L‡ + 16 L‖	28
Greece	Compulsory Service	22,104	82,000	120	2 A + 8 R + 8 L‡ + 10 L‖	28
Holland	Conscription and Voluntary	27,366	68,000	120	1 A + 1 R + 3 L‡ + 10 L‖	30
Italy	Compulsory Service	261,728	3,330,000	1,726	2 to 5 A + 7 or 4 R + 10 L‡	19
Japan	Conscription	143,649	§509,960	684	3 A + 4 R + 5 L‡ + 11 L‖	23
Mexico	Conscription and Voluntary	29,904	146,500	96		30
Norway	Conscription and Voluntary	30,900	80,000	66	50 days A + 6 R + 6 L‡ + 4 L‖	16
Roumania	Compulsory Service	63,280	173,948	366	3 A + 6 R + 5 L‡ + 4 L‖	18
Russia	Compulsory Service	1,100,000	§4,600,000	5,000	4 A + 13 R + 5 L‡	22
Spain	Conscription	119,432	500,000	408	3 A + 3 R + 6 L‡	12
Sweden	Conscription and Voluntary	37,200	570,000	240	68 days or 3 years A + 8 R + 4 L‡ + 8 L‖	20
Switzerland	Compulsory Service	20,122	526,105	288	½ A + 11½ R + 12 L‡ + 6 L‖	30
Turkey	Compulsory Service	216,530	1,150,700	1,356	4 A + 2 R + 8 L‡ + 6 L‖	20
United States	Voluntary	63,686	100,000	504	3 A.	3

* A = Active Army. R = Reserve. L‡ = Landwehr, or Territorial Army. L‖ = Landsturm, or Territorial Reserves.

† The war strength of the various armies can only be given in round numbers as official figures are not published.

‡ Estimates of 1903–4. This total includes the British forces in this country, India, and the Colonies (excluding colored men). Does not include volunteers, militia, etc., at home.

§ Subject to modification by very severe losses.

—*Daily Mail Year Book.*

FOREIGN ARMIES.

The latest particulars relating to the military power of the countries of Europe, Abyssinia, China, Egypt, Japan, Mexico, etc., from Hazell's Annual for 1904, will be found below.

ABYSSINIA.

The organization is feudal in character, and the constitution is by provinces, each governor or Ras having a standing force as garrison and at call in case of war, and a considerable number of retainers not embodied. The garrison forces united constitute the new army of Menelik, and are estimated at 70,000 men. The central control is weak, and there are no organized divisions into the three arms, as in Europe; but the forces are readily grouped, the mounted men forming an irregular cavalry, and have great mobility. Practically every man has a sword and a rifle, but the firearms are extraordinarily varied, and the mounted troops also carry a javelin or spear. They do not exceed 5,000 altogether. The guns are mostly adapted for mountain work, there being about 50 modern and 30 old ones. The unembodied retainers, who may be likened to a militia, number about 140,000 men.

ARGENTINA.

The army is sanctioned by an annual vote, as in Great Britain. The standing force and reserve consist of 120,000 men (18 battalions of Infantry, 12 regiments of cavalry, 8 of artillery, and 4 battalions of engineers). Outside these are the National and Territorial Guard, which have little training. Compulsory military service (25 years in all) was adopted in 1901, and it is believed that 500,000 men could be mobilized in case of war.

AUSTRIA-HUNGARY.

The active army of the Dual Monarchy is an organization common to both kingdoms, and has its Ersatz, or supplementary Reserve, with local forces for Bosnia and Herzegovina attached. There are fifteen army corps, and certain troops in the military districts of Zara in Dalmatia. In addition are the Austrian Landwehr and Landsturm and the Hungarian (or Transleithan) Landwehr and Landsturm, known as the Honved.

During 1903 the army question rose to great prominence between the national parties in Austria and Hungary, and certain concessions were made to the latter in regard to the language of command, regimental colors, and other matters, but these do not affect the unity of the army.

The fifteen army corps comprise 5 cavalry divisions and 31 infantry divisions of the active army, and on mobilization a Landwehr division would be attached to each. There are 466 battalions of infantry (102 regiments of the line, 4 of Tyrolese rifles and 4 Bosnian, and 26 battalions regular rifles. The cavalry on a peace footing comprises 252 squadrons (15 regiments of Dragoons, 11 of Uhlans, and 16 of Hussars), and the artillery 251 batteries, exclusive of 18 battalions of fortress artillery and 15 of pioneers. The field artillery is formed in 14 brigades, and a group of 3 mountain batteries in the Tyrol. On a peace footing there are 224 field batteries, 16 horse batteries, 11 mountain batteries, 56 ammunition columns (in skeleton), and 56 depots. The war strength would give a total of 328 batteries (exclusive of fortress units), with a total of 2,464 guns. The Austrian and Hungarian cavalry have won the admiration of European soldiers, and the Empire unquestionably possesses a thoroughly practical mounted arm fit for service at a moment's notice.

The following table shows the total strength of the forces in 1903; but it is believed that by embodying all classes of the Landsturm the dual monarchy could put 3,000,000 men in the field.

Forces.	Peace.	War.
Field Army..........	266,000	687,000
Landwehr and Honved.	51,000	237,000
Reserve troops........	6,000	192,000
Fortress troops.......	7,000	31,000
Transport Staff, etc...	16,000	....
Landsturm..........	......	393,000
	346,000	1,540,000

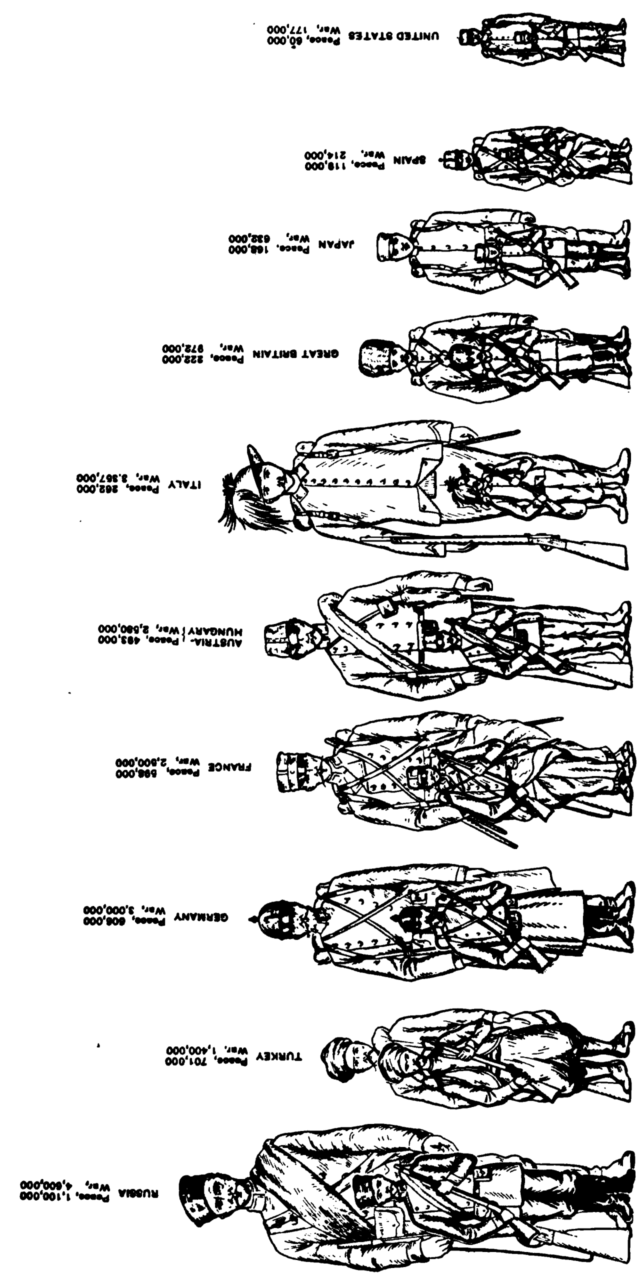
The Honved (national Hungarian army) is subject in war time only to the commander-in-chief, and in peace time only to the Royal Hungarian jurisdiction.

BELGIUM.

The Belgian army was recently reorganized as the outcome of a popular agitation, leading to the appointment of a mixed commission which prepared a scheme. The main feature was the adoption of volunteer enlistment, with the purpose of bringing about a progressive decrease in the annular levy by subscription. Special advantages were offered, but the result has been very disappointing.

The establishment on Oct. 1st, 1903, when the recruits were embodied, was 42,000 men, but there was a deficiency of 7,000, owing to substitutes not having been found for men who had been absolved from service. The regiments were in some places so weak that training was impossible. The nominal liability is eight years with the colors and five in the reserve, and the recruit contingent is 13,300, the volunteers being in addition.

The composition is as follows: Cavalry—2 regiments of chasseurs, 2 of guides, and 4 of lancers. Each regiment consists of 4 squadrons active and 1 reserve. To the above have to be added the gendarmerie (over 1,700



PEACE AND WAR FOOTING OF THE ARMIES OF THE WORLD.

men). Artillery—4 field and 4 fortress regiments (in all 204 guns). Engineers—1 regiment of 3 battalions, a reserve battalion, and 5 special technical companies. Infantry—14 regiments of the line, of 4 battalions of 4 companies each, 3 active and 1 reserve battalion; 1 regiment of grenadiers, similarly organized; 1 regiment of carbineers of 6 battalions (4 active and 2 reserve), and 3 regiments of *chasseurs-à-pied*.

The Civic or National Guard is under the Minister of the Interior in peace time, and numbers approximately 45,000 men reckoned as "active," and 100,000 "non-active." The effect of the new law cannot yet be estimated fully.

BRAZIL.

Gradual progress is being made in the reorganization of the army, but much remains yet to be done. The strength and organization, given in the official *Revista Militar*, is as follows: staff, 28; engineer corps, 66; general staff corps, 124; medical staff, 163; artillery staff, 62; 6 regiments of artillery, 2,562; 6 battalions of artillery, 2,100; 2 battalions of engineers, 862; 14 cavalry regiments, 6,020; 1 transport corps, 292; 40 infantry battalions, 17,840; total, 30,119. The troops are divided into seven military districts, the most important being Rio Grande do Sul (11,226 men).

BULGARIA.

Military service is popular, and the peasantry have a great deal of excellent military spirit. The officer is also efficient, and the Government has taken very great care in selection and training, the Russian army being the pattern.

The forces are divided into three categories: the regular army, the reserve and the militia, and all Bulgarians are liable for personal service, with few exceptions, from the age of 20 to 45, substitution not being permitted. The country is divided into six divisional districts, and the annual contingent is about 18,000 men.

The peace strength is: infantry, 1,300 officers and 28,550 men; cavalry, 200 officers and 3,850 men; field artillery, 280 officers and 5,020 men; mountain artillery, 45 officers and 900 men; fortress artillery, 65 officers and 950 men; engineers, 18 officers and 1,900 men; transport, 20 officers and 160 men: total, 1900 officers and 41,330 men.

The total war strength is 3,810 officers, 202,500 men, and 29,200 horses. In addition Bulgaria can count upon at least 20,000 *Komitajis*, a force of semi-trained and experienced guerillas. The infantry arm is the 8 mm. Mannlicher rifle.

CHILE.

The army does not exceed 6,000 men, in accordance with the law of Feb. 2d, 1892, and the formations are: 7 regiments of infantry, 4 of cavalry, 3 of artillery, and a corps of engineers. The National Guard numbers over 50,000 men.

CHINA.

The Chinese army came under close observation during the Boxer Rebellion, and, although in many ways it gave proof of want of organization, it was recognized that in armament, training, and the things that go to make up the efficiency of the army, remarkable progress had been made. General Frey who commanded the French forces in China, says it is a mistake to hold that the Chinese Government has any repugnance to the creation of military forces. The Emperor is said to have issued an order extolling military discipline and disavowing any purpose of disarmament, and training is going on under Japanese officers. The Black Flags are now a force of real value.

It was never easy to ascertain facts concerning the Chinese forces. They may be divided into the old armies, comprising the Imperial or Banner troops; the new armies, composed of troops of comparatively recent formation (since the war with Japan); and the Mongolian and Thibetan Militias, which in peace time only exist on paper.

The *élite* of the old armies is composed of the Shen-Che-Ying or Black Flag troops, and the Pa-Ki or Eight-Banner men. The former are said to number 50,000 men with the colors. Next in importance to the Black Flags come the Banner men of the army of Manchuria, composed of soldier-like troops, but some of them still armed with bows and arrows, or with the old jingal. The Banner men have been estimated at something like 300,000. Service with the Manchus is hereditary, and the Banner men are still the chief support of the Ta-tsing dynasty. The army of Manchuria must be profoundly affected by the Russian occupation of the country. The Luh-Ying or Green Flags, with a paper strength of 500,000 men, scattered through the empire, possess little military value, and as now organized can be of no real service.

The new armies consist of enrolled or conscript armies (irregulars), strength about 100,000 men, raised at the initiative of the viceroys and governors of provinces in the event of revolution or of war with Europeans; and the active armies, dressed like Europeans, and formed of the best men drawn from the Green Flag Army—strength 210,000 men. These troops occupy important strategic points, and are under the orders of the provincial authorities. The best of them are in the province of Chi-Li, where the army was reorganized by Yun-Hu and Lu-Chang.

Before the Boxer troubles, Major A. E. J. Marshall, of the British Army, one of the best authorities, summed up the number and disposition of the whole available force of China thus:

FIGHTING TROOPS.

Manchurian Field Force	50,000
Manchurian Irregulars	50,000
Fighting Braves	125,000
Chien-Chun, or Disciplined Troops	10,000
	205,000

RESERVES UNDER ARMS.

Peking Field Force	13,000
Banner Troops in Peking	75,000
Banner Troops in Provinces	95,000
Luh-Ying, or Green Flags	506,000
	689,000

DENMARK.

Service is obligatory on all able-bodied men who have reached the age of 22. Terms of service, eight years with the colors and eight in the extra reserve. A reorganization of the Danish army was introduced in 1894, and the late War Minister, General Bahnson, calculated that the contingent brought under training 7,947 men yearly. The service in the various branches of the army is 16 years; but, reckoning 14 years only, and allowing for waste, the General concludes that by the year 1910 Denmark will be able to mobilize 83,000 men, of whom 58,500 will be infantry, 5,000 cavalry, 6,800 field artillery, and 8,600 fortress artillery. The really effective force would be about 70,000. At present the peace strength (31 battalions, 16 squadrons, and 12 field batteries, with fortress artillery and engineers) is 13,750, increased on mobilization to 50,000.

EGYPT.

The Egyptian army, under strong leadership and the command of British officers, has shown excellent quality. All the inhabitants are liable for service—six years in the army, five in the police, and four in the reserve, and there are always about 150,000 young men on the rolls for conscription; but the burden is very light, and the men are all selected. The cavalry are recruited from the fellaheen of the Delta. The infantry battalions are drawn mostly from the fellaheen, but several are Soudanese blacks. The first are filled by conscription, and have about 800 men each, mostly fellaheen, in 6 companies. The interior economy and drill of the recruits is excellent, and the musketry good. The arm is the Martini-Henry. In the Soudanese battalions the service is voluntary. This force was raised largely from the Khalifa's black riflemen, but men from Lower Egypt have been enlisted.

The artillery is the force that shows most markedly the impress of the European training. The horse battery has Syrian horses and light Krupp guns. The field batteries have Krupp mountain guns carried by mules, with a second line of camels. There is also a battalion of garrison artillery, organized as in our service.

The Egyptian Army has been reduced recently, owing to the smaller demand for its services, and some of the Soudanese have been disbanded. About 8,000 men have left the colors. The command is vested in Major-Gen. Sir Reginald Wingate, with the title of Sirdar.

The British forces in Egypt are 4 regiments of infantry, 1 of cavalry, 2 field batteries, and detachments of fortress artillery and engineers, with a strength of 5,482 in 1903-4.

FRANCE.

The French army is administered by the War Departments, or Ministry of War, with General Andre at its head, assisted by a military cabinet and the chiefs of various bureaux. The chief of the general staff of the army is responsible to the Minister, and controls the directorates of infantry, cavalry, engineers, artillery, finance, etc.

In 1904 the effectives with the colors are estimated as follows: 29,000 officers, 520,831 men, and 142,474 horses, being a diminution of 76 officers and 6,228 men as compared with 1903. The establishment will be 515,600 men. The smaller number embodied results from the contingent being less than in previous years.

The Active Army is constituted as follows: 652 battalions of infantry, 30 battalions of chasseurs, 10 foreign, 20 zouaves, 24 Algerian tirailleurs, 1 Saharan tirailleurs, and 5 African light infantry: total, 742 battalions, 13,370 officers, 24,432 non-commissioned officers, 342,068 men: total, 379,890. The cavalry form 31 regiments of dragoons, 21 of chasseurs, 14 of hussars, 13 of cuirassiers, 6 of chasseurs d'Afrique (all of 5 squadrons), and 4 of Spahis, variously constituted, numbering in all 448 squadrons, 3,891 officers, 4,552 non-commissioned officers, 64,756 men: total, 73,199, and 61,028 horses. The organization of the artillery is as follows: field batteries, 434; horse batteries, 52; mountain batteries, 22; foot (or fortress) batteries, 112: in all, 620; officers and men, 77,213. The engineers (including railway troops) number 7 regiments, 20 battalions and 3 railway companies) with telegraphists, ballooning troops, etc., officers and men, 13,426; and the military train has 20 squadrons (comprising 72 companies), officers and men, 8,167.

In relation to the organization given above, it must be noted that owing to the class embodied in November, 1903, consisting only of 196,000 men, as compared with 238,000 enrolled in the previous year, it has been decided to abolish 68 companies of the fourth battalions of regiments which had not been completely formed. These fourth battalions were raised in 1897, and could only be properly organized in 93 out of 145 subdivisional regiments. In consequence of the latest abolition there remain only 65 fourth battal-

ions, not including the 18 belonging to district regiments, which are all up to strength.

The forces are organized in 20 army corps, exclusive of the Paris garrison; their headquarters being at Lille, Amiens, Rouen, Le Mans, Orleans, Chalons-sur-Marne, Besancon, Bourges, Tours, Rennes, Nantes, Limoges Clermont-Ferrand, Lyons, Marseilles, Montpelier, Toulouse, Bordeaux, Algiers, Nancy.

A proposal is before the French parliament for reducing the period of service with the colors to two years, and it is the general opinion that the measure will become law. It is proposed to embody a considerable number of re-enlisted men in order to make good the deficiency that will arise.

Under the existing rules every Frenchman should serve three years in the active army, ten years in the reserve of the active army, six years in the territorial army and six years in the reserve of the territorial army. For administration, training and mobilization, the units of the territorial army, as well as the active reserve, are attached to the corresponding units of the active army. The reserve troops are: 145 infantry regiments, 30 chasseur battalions, 38 cavalry regiments formed with the line and light cavalry regiments of the corps cavalry brigades, 41 other squadrons formed with the divisional cavalry regiments, and 216 batteries of field artillery. 12 to each artillery brigade. The territorial forces are 145 battalions of infantry, 7 of rifles, 10 of zouaves, 40 battery groups of field artillery and 16 of foot artillery, 21 battalions of engineers, and 19 squadrons of train. There are special dispositions in regard to some army corps, and a large number of battalions and independent companies are employed in the customs and forest service. In regard to the localization of the troops, it should be noted that a large force is quartered on the German frontier, where the 6th corps has been divided into two, and a new corps thus created. The reserve of the active army includes about 1,320,000 men, and the Territorial Army and its reserve about 2,270,000.

It has been estimated that the French army, with its various reserve and territorial forces, includes 3,500,000 trained men on a war footing, and that 4,000,000 untrained men might be embodied.

The French colonial army has been brought under the authority of the Ministry of War, and comprises 6 brigades of infantry, 12 battalions of field artillery, 6 mountain batteries, and 12 garrison batteries.

In Madagascar and Indo-China are 10 battalions of French and 18 battalions of native infantry, and 4 field, 6 mountain, and 5 garrison batteries; in West Africa, 2 French and 8 native battalions, 2 mountain and 3 garrison batteries; in Martinique, 7 French and 10 native battalions, and 2 field, 3 mountain and 3 garrison batteries; and in various other stations some 6 French and 3 native battalions, with 1 mountain and 5 garrison batteries. For some time past France has been strengthening her military forces in French Indo-China, where there are now at disposal 3 brigades of troops in actual existence, with a reserve brigade. The approximate strength of the native forces in the colony is as follows:

French infantry, 3 regiments....	3,000 men
Foreign Legion, 4 battalions	3,000 "
Native infantry, 6 regiments	18,000 "
"Milice indigene" (native constabulary)................	10,000 "
Total of infantry	34,000 "

GERMANY.

The administration and command of the army is exercised through the great general staff, a most powerful and efficient organization, by which the work of the army is prepared for in peace and molded in war. It is at once a close and yet flexible organization, which permeates the whole structure of the army, consisting for Prussia of about 200 officers. Nearly 100 of these are detached on service with the staffs of corps or divisions, while the remainder constitute the great general staff in Berlin. There is constant interchange between regimental work and staff work, and between the latter locally and with the headquarters staff in Berlin. Scarcely any regimental officer rises high in his corps without having been called to staff service; so that the ideas of the staff are based upon practical experience, and react upon the whole army, to which they come as a kind of tradition of duty and policy, sharpening and directing the life and work of the army. Recently the inspection of the cavalry and artillery has been improved.

The forces are organized in 22 army corps, and comprise 625 battalions of infantry, 482 squadrons of cavalry, 754 batteries of artillery, 38 battalions of foot artillery, 25 battalions of pioneers, 11 battalions of Army Service troops, and 23 battalions of train, with a peace strength of 495,500 rank and file, exclusive of one-year volunteers. The establishment is given as 620,918. The contingent annually embodied approaches 275,000 men. The service in the standing army is of six years, two of these with the colors in the infantry and three in the cavalry and horse artillery, and the rest in the reserve. After quitting the reserve of the Active Army the soldier passes five years in the Landwehr and seven in its reserve. The recruiting service of the Guard, conisting of the tallest and finest-looking men, is carried out by a committee, consisting of officers specially nominated for the purpose. Under the system of recruiting there are always more men than are necessary to keep up the army strength, the surplus constituting the Ersatz Reserve.

The strength upon mobilization is estimated at 2,310,000 infantry, 151,000 cavalry, 329,000 artillery, 78,000 technical troops, 168,000 other formations, making a total of 3,036,000 trained men.

GREAT BRITAIN.

Under the new system, the British Army has been organized in Army Corps. It was designed to form six of these, but up to the present time only four have been constituted.

The organization of a British Army Corps is as follows:—Infantry, 25 battalions; artillery, 150 guns—viz., 18 batteries of field artillery, two batteries horse artillery, three batteries of howitzers, and three batteries of 4.7-in. guns. These last batteries have only four guns each, all the others six. The cavalry of an Army Corps includes two regiments, one immediately attached to the Divisions, the other to the Special Corps troops, and, in addition, for purposes of peace organization, there is a cavalry brigade of three regiments in each Army Corps command.

The local organization of the Army Corps districts does not supersede that of the older regimental districts, of which there are 67, each under the command of a colonel. The regimental district is the recruiting ground of a territorial regiment, with which are linked, as junior battalions, the militia and volunteer corps within the area; and the reserve men are pensioners of their respective territorial regiments. The Royal Artillery, through 9 recruiting areas, and the Royal Engineers, through the commanding Royal Engineer in each district, have also a territorial organization; but this is not the case with the Cavalry, which has special recruiters or staff officers located in various districts. In theory, one battalion of each Infantry regiment is at home, as a feeder for the other abroad; but in practice this system has never been uniformly maintained, and was completely dislocated by the war in South Africa. The Army Service and several departmental corps are part of the organization.

The following is the organization of the Regular Army according to the units of each arm of the service. The strength is given below:

Household Cavalry	Regiments	3
Cavalry of the Line	do	28
Horse Artillery	Batteries	30
Field Artillery	do	158
Mountain Artillery	do	11
Garrison Artillery	Companies	111
Royal Engineers	do	100½
Foot Guards	Battalions	10
Infantry of the Line	do	161
Army Service Corps	Companies	72
R. A. Medical Corps	do	56
Army Ordnance Corps	do	24

In addition to these are Colonial Corps and Indian Infantry in Egypt, Barbados, Jamaica, Bermuda, Malta, West Africa, Mauritius, Ceylon, China, and Hong Kong, the Straits Settlements, etc.

The Army Reserve is a vital element in the Army organization, the Reserve men being liable by the terms of their agreement to general service with the arms in which they were enrolled with the colors. The Reserve was profoundly affected by the war in South Africa, and the general mobilization of the force showed that the force could be relied upon. Reservists, who have served their period with the colors, and who are of the best soldiering age, and available for service if required, are an excellent set of men. The reserve men are pensioners of the respective territorial regiments, and look to the officer commanding the district as their commanding officer.

The establishment as at present authorized is 80,000. Subsequently to the war men have been drafted in large numbers to the Reserve, and the numbers increased by 18,288 between Jan. 1st and April 1st, 1903. The Reserve comprises Sections A, B, C and D, the B section being the most important, comprising all who have enlisted for short service and have discharged their active duties. The following was the strength of the several sections on Jan. 1st, 1903: A, 328; B, 28,759; C, 697; D, 3081: total, 32,865.

A new scheme for the enlistment of railway employés into the Reserve, through the agency of the Engineer and Railway Volunteer Staff Corps, and under the direct supervision of the commandant of that corps, has borne fruit, and bids fair to be a success.

A further reserve force connected with each regimental district is the Militia Reserve, to be embodied with the Militia upon mobilization.

MILITIA.

During the Boer War the Militia, though it was kept in the background, accomplished what no other branch of the army could do. Without external aid it provided a large number of organized and completed battalions for home, foreign, and active service, thus maintaining its old traditions, and demonstrating its high value among the military forces of the Crown. The service upon the lines of communication was most arduous. The Militia is a force of very old standing, the purpose of which is to provide a body of trained men, available in case of need or of imminent national danger, to supplement, support, or relieve the regular army at home and on the Mediterranean stations. There are in all 124 Infantry battalions attached to the Line regiments, 32 corps of Garrison Artillery, 3 Field Batteries, 2 fortress corps of Engineers, 10 divisions of Submarine Miners, and 2 companies of the Medical Staff Corps. The Malta regiment, some colonial corps, and 8 Channel Island regiments are in addition. It has often acted as a feeder to the Regular Army, and, under the territorial system, this has come to be regarded as its chief function. A very large number of militia recruits are every year transferred to the line—as many, indeed, as

one-third of the whole number enlisted—and the force is a channel through which many commissions are annually gained in the regular Army. This system is to be continued. Great dissatisfaction was felt owing to the retention of Militia battalions for so long a period in South Africa, whereby a real hardship was inflicted upon officers and men, and the feeling is general in the force that it is neglected.

The Militia recruit is enlisted for six years, and may re-engage if under 45 years of age for a further period of four years. Recruits are liable, at any time after enlistment, to be assembled for preliminary drill for such period, not exceeding six months, as may be directed, from time to time by the Secretary of State for War. Brigades and regiments are called out annually for 27 days' training, which may be extended to 56 days if deemed expedient.

The Lord-Lieutenant of a county recommends to the consideration of the Secretary of State for War, for submission to His Majesty, the names of candidates for first appointment to Commissions, commanding officers being directed to assist him in the selection if called upon. For subaltern officers in the Militia, candidates must be seventeen years of age or upwards. The appointment of officers as captains and field officers is recommended by the Militia commanding officer direct.

The New Militia Reserve, to be formed as a "Reserve Division of the Militia," was authorized by a Royal Warrant (Feb. 4th, 1903), under the Militia and Yeomanry act, 1892, and has an establishment of 50,000. It is intended to raise the force in round numbers from 100,000 to 150,000, and, in order to stimulate recruiting, men joining from the garrison Regiment receive $30 annually, and other men $22.50, with quarters and rations during training. The arrangements for musketry training are to be increased. Men of the Reserve Division are liable to serve with the Militia whenever that force is embodied by proclamation.

The services of the Imperial Yeomanry in South Africa, in the organizations of which the old Yeomanry Cavalry played a very large part (although in the actual composition of the force the regular yeomen formed only about one-fifth of the total strength), caused the military authorities to reorganize the force. An Army Order of April 17th, 1901, provided that it should, in future, be entitled the "Imperial Yeomanry," and that the brigade organization should be abolished, and the force be organized in regiments of four squadrons, with a regimental staff and a machine-gun section. The order included rules as to efficiency, drills, and pay. During the period of training, and under conditions laid down, the daily pay, including ration allowance, varies from $1.35 in the case of a private to $2.38 in the case of a regimental sergeant-major, with 1s. additional when a non-commissioned officer acts as quartermaster. It was also announced that after Oct. 31st, 1901, all corps of Volunteer light horse and Volunteer companies of mounted infantry would be disbanded or merged into squadrons of the Imperial Yeomanry. The number of regiments so far constituted is 52. A Committee on the organization of arms and equipment of the Yeomanry Force reported upon the subject in January, 1901, and it was decided, under the new Army scheme, to provide the Yeomanry with rifles, to give them extra pay as indicated above, with horse allowance of $25 and to raise the force to 35,000 as Imperial Yeomanry intended to furnish mounted troops for home defense, while Colonial Yeomanry are to be affiliated for Imperial services. There is a school for instruction for officers of Imperial Yeomanry, with a lieutenant-colonel as commandant and a staff of 66.

THE VOLUNTEERS.

Volunteer corps are raised under the Volunteer Act 1863 (26 & 27 Vict., c. 65). They are subject to the provisions of that Act and any Acts amending it, and likewise to all regulations made with regard to Volunteer corps. The Volunteer (Military Service) Act of '96 provides that whenever an order for the embodiment of the Militia is in force, any member of a Volunteer corps may offer himself for actual military service, and if the services of such members of any corps are sufficient to enable them to be separately organized are accepted, then those members may be called out either as a corps or as part of a corps. Under the Volunteers Act 1900 new regulations were made as follows:—I. A member of a Volunteer corps may contract to come out for actual military service in Great Britain whenever summoned, and to serve for a period not exceeding one month in the absence of a Royal Proclamation calling out the Volunteers generally. II. A member of a Volunteer corps may contract to proceed upon active service to any part of the world in a unit or company formed of Volunteers, on special conditions as defined by the terms of his contract.

The Volunteers, like the Militia, form junior battalions attached to the line regiments in their respective districts. Their own organization as a cohesive and independent fighting force is still imperfect, and the new Army scheme proposes a much higher level of efficiency and an improved organization.

Like the Militia, the Volunteers hold a considerable place in the new Army scheme of 1901-2, and now enter into the composition of the fourth Army Corps. The force numbers 223 battalions, and of these 27 are included in the Army Corps scheme. The Volunteers are to be specially trained for its work with the Army Corps and for positions round London, while increased drill and rifle shooting are to contribute to efficiency. The Government programme for reorganizing the Army, presented in February, 1900, included the providing for extended training in camp during the

summer and for the supply of regimental transport and caused very considerable difficulty and dissatisfaction. The view of the War Office is that if Volunteers cannot conform to the new regulations, they must face some reduction of numbers, since it would be more to the purpose of the Government to get a smaller body of efficient men upon which it could rely. A controversy has raged round this point, and it was contended by many Volunteers that the most zealous among them could not conform to the requirements. The returns of Nov. 1st, 1902, showed a considerable decline in numbers as compared with the previous year (268,550 as compared with 288,476), and a decrease in the percentage of efficients to the enrolled strength (95.49 as compared with 97.43), and in numbers present at inspections (77.48 as compared with 83.93). The decline has been continued. Particulars are given below.

EFFECTIVES AND DISTRIBUTION.

Establishment and Strength of Army, Army Reserve, Militia, Imperial Yeomanry, and Volunteers on Jan. 1st, 1903 (all ranks).

Forces.	Normal Establishment	Actual Strength	Wanting to complete
Army, Regular:			
Forces, Regimental Establishments	284,378	*324,653	—
General and Departmental Staff and Miscellaneous Establishments	2,400	2,400	—
Army Reserves, Class I	80,000	32,865	47,135
Militia	131,737	108,568	23,169
Militia Reserve (New)	50,000	†	50,000
Channel Islands and Colonial Militia	6,002	5,068	934
Imperial Yeom'nry at Home	35,164	22,942	12,222
Volunteers	346,450	250,990	95,460
Bermuda Rifle Volunteers	319	233	86
General total	936,450	747,719	188,731

ACTUAL STRENGTH OF THE REGULAR ARMY BY ARMS.

Household Cavalry	1,490
Cavalry of the Line	29,297
Imperial Yeomanry	1,610
Royal Horse Artillery and Royal Field Artillery	34,959
Royal Garrison Artillery	23,174
Royal Engineers	13,757
Foot Guards	9,966
Infantry of the Line	176,580
Colonial Corps and Indian Infantry borrowed for garrison and expeditionary purposes	15,503
Army Service Corps	8,443
Royal Army Medical Corps	6,020
Army Ordnance Corps	2,638
Army Pay Corps	853
Army Post Office Corps	362

*Parliament in 1902 sanctioned 200,300 excess numbers.

†Not formed on Jan. 1st, 1903.

It appears from the General Annual Return of the Army that in the year ending Dec. 31st, 1902, 51,677 recruits joined (2,317 for long service, 49,360 for short service), as compared with 47,039 in 1901.

THE STRENGTH OF THE ARMY RESERVE from 1898 to 1903 has been as follows:—1898, 82,063; 1899, 78,839; 1900, 24,388; 1901, 5,434; 1902, 2,573; 1903, 32,865. The reduced numbers since 1901 have been due to Reservists being embodied with the Regulars for the war. The establishment is 80,000, and on April 1st, 1903, the strength had increased to 51,153, leaving 28,847 wanting to complete the establishment. It is impossible to give satisfactory details, there being a large number of men on gratuity furlough, eventually to be transferred to the Reserve.

CHANGES IN ESTABLISHMENT AND EFFECTIVE OF THE MILITIA during the last seven years, exclusive of the permanent staff:

Date.	Effective strength	Establishment	Wanting to complete
1st Jan., 1896	108,350	126,723	18,373
" 1897	107,878	126,609	18,731
" 1898	105,531	125,435	19,904
" 1899	103,647	124,481	20,834
" 1900	98,130	123,137	25,007
" 1901	92,741	124,252	31,511
" 1902	102,845	123,993	21,148
" 1903	131,737	108,568	23,160

The figures from 1900 onwards do not include Militia Reservists called out on permanent service with the Line. Recruiting in 1902 showed a material increase—41,486, as compared with 37,644 in the previous year. Returns are not available for 1903.

The new Militia Reserve has an established strength of 50,000. Its formation began in 1903, but particulars are not available of the effective attained.

ENROLLED STRENGTH OF THE IMPERIAL YEOMANRY in 1902, 21,840, and the number present at the inspection 19,570. The establishment being 35,164, the number wanting to complete was 13,324. On Jan. 1st, 1903, the enrolled strength had increased to 22,945, the recruits numbering 8,845, and the net increase during the year 1902 having been 5,546. These figures are exclusive of Imperial Yeomanry in South Africa (2,449 raised in 1902), who are included in the strength of the Regular Army, and certain regiments not yet formed are included in the establishment. On Jan. 1st, 1903, the establishment of the recruits formed was 30,992, and the strength 22,942.

STRENGTH OF THE VOLUNTEERS.

The conditions affecting unfavorably the strength of the Volunteers have been given above. The establishment is 346,450, and the actual strength by the latest return (Jan. 1, 1903) 250,990, leaving 95,460 wanting to complete. The enrolled strength has been as follows since the establishment of the force:
'60, 119,146; '61, 161,239; '62, 157,818;
'63, 162,935; '64, 170,544; '65, 178,484;
'66, 181,565; '67, 187,864; '68, 199,194;
'69, 195,287; '70, 193,893; '71, 169,608;
'72, 178,279; '73, 171,937; '74, 175,387;
'75, 181,080; '76, 185,501; '77, 193,026;
'78, 203,213; '79, 206,265; '80, 206,537;
'81, 208,308; '82, 207,336; '83, 209,365;
'84, 215,015; '85, 224,012; '86, 226,752;
'87, 228,038; '88, 226,469; '89, 224,021;
'90 221,048; '91, 222,046; '92, 225,423;
'93, 227,741; '94, 231,328; '95, 231,704;
'96 236,059; '97, 231,796; '98, 230,678;
'99, 229,854; 1900, 277,628;
1901, 288,476; 1902, 268,550. The later return mentioned above (250,990) shows a further falling off of 17,560, and it is believed that the diminution has not ceased. The shortage of officers on Jan. 1st, 1903, was 1895.

GREECE.

Service is for two years with the colors and eight in the reserve, eight in the National Guard and ten in its reserve; the cavalry, however, spending ten years in the National Guard and eight in its reserve.

The Standing Army consists of ten infantry regiments, eight battalions of light infantry and rifles, three cavalry regiments, and three regiments of field artillery. The Gendarmerie consists of sixteen divisions, and the men are borne upon the strength of the line. The peace strength of the army is about 1880 officers and 25,000 men. As a matter of fact these numbers are never attained under ordinary circumstances, the number with the colors varying from 16,000 to 18,000. There are three general commands. The total war strength is 82,000 men and 114 guns. Including the territorial army, and its reserve, there are said to be some 160,000 men available, but the organization is very defective. The Evzonoi highlanders are by far the best troops.

ITALY.

The Italian army consists of the Active Army, the Mobile Militia, and the Territorial Militia. There are 12 army corps, each having 2 infantry divisions, except that in the Rome district, where are three. The organization of the permanent army comprises 96 regiments of line infantry (288 battalions), 12 regiments of bersaglieri (36 battalions) and 7 Alpine regiments (22 battalions). The strength varies considerably, the company having upon a peace strength a maximum of 100 and a minimum of 60, with a mean of 80, known as the *forza bilanciatia*. Large numbers of men are upon what is known as unlimited leave. There are 24 regiments of cavalry (144 squadrons), each squadron having a mean strength of 145 men and 124 horses. There are 24 regiments of field artillery, with 186 6-gun batteries, but in peace time the battery has only 4 guns. The army also comprises 1 regiment of horse artillery (6 batteries), 1 of mountain artillery (12 batteries), 1 brigade of mountain artillery, with 3 batteries in Venetia, 3 regiments of coast artillery and a brigade in Sardinia, 2 regiments of fortress artillery and 5 of engineers, comprising 60 companies of the various branches.

The total strength of the forces is given as follows:

	Officers and Men.
With the colors	248,111
On unlimited leave	486,290
Mobile Militia	320,170
Territorial Militia	2,275,631
Total	3,330,202

There are about 1,250 guns with the Regular Forces and 378 with the Mobile Militia.

JAPAN.

The military forces of Japan are the Permanent Army, with reserves and recruiting reserves, the Territorial Army, the National Militia and the militia of certain of the islands. The Permanent Army is available for foreign service, the Territorial Army for home defense, and the militia for auxiliary operations in more distant parts of the country.

Service is personal and obligatory from the age of 17 to 40. The total actual period is 12 years and 4 months, of which 3 years are in the Regular Army, 4 years and 4 months in the Reserve, and 5 years in the Territorial Army. The recruiting reserve is drawn from the excess of the contingent, and the men, after passing their 7 years and 4 months in the Reserves, pass to the Militia.

The Emperor is supreme head of the army, and military affairs are directed through the War Minister and the Chief of the General Staff by the Superior War Council. In order to insure unity of action between the various branches of the navy, there is a council consisting of the War Minister, the Naval Minister, the chiefs of the General Staff and the Naval Staff and the Director-General of Military Training.

The following are details of the effective strength of the army on a war footing, not comprising the troops in the island of Formosa: Administrations and establishments, 1,000 officers, 2,900 men; Permanent Army, infantry, 156 battalions; cavalry, 55 squadrons with 9,000 horses; field artillery, 19 regiments of 6 batteries with 684 guns; fortress artillery, 20 battalions; engineers, 13 sapper battalions and 1 railway battalion; transport, 13 battalions: total, 203 battalions, 55 squadrons, 684 guns; or 7,500 officers, 193,790 men,

61,390 horses. Depot troops: 52 battalions, 17 squadrons, 26 companies, 19 batteries; or 1,000 officers, 34,600 men, 9,000 horses, 114 guns. Territorial Army: 130 battalions, 26 squadrons, 312 guns, 3,200 officers, 118,530 men, 11,860 horses. Militia: 35 officers, 1,180 men, 210 horses. Grand total, 386 battalions, 26 companies, 99 squadrons, 1,116 guns, 11,735 officers, 348,100 men and 84,460 horses. The total fully trained force, according to the *St. Petersburg Gazette*, is 509,960. The Military College and Academy train accomplished officers of great intelligence. They were pronounced by General Grant to be among the foremost of the kind in the world. The barracks and gymnasia are of the best type, and every care is paid to the physical development of the men.

MEXICO.

The Mexican army consists in peace time of 3,500 officers, 31,000 men, and 11,000 horses or mules. It was proposed to introduce personal or obligatory service, but the plan has been postponed, and the army is recruited by voluntary engagement of 3, 4 and 5 years, with special levies drawn by lot. The passage of the forces to a war footing has been defined by law, and provision is made for mobilizing the first and second reserve, including the rural and urban police, the national guard and other forces.

The following is the strength: Regular army, 2,700 officers, 61,000 men; reserves, 1,000 officers, 155,000 men; total, 3,700 officers, 186,000 men, with 32,000 horses and 12,000 mules.

MOROCCO.

The Sultan's forces comprise about 30,000 excellent men of all arms, under command for training of Kaid Sir Harry Maclean. The infantry arm is the Martini.

THE NETHERLANDS.

Holland has at present no standing army, but a cadre of officers and non-commissioned officers (establishment about 2,200) for training the forces embodied.

The Landwehr, which has replaced the old Schutterij, received its first contingent recently, and the country has been divided into 48 Landwehr districts. The corresponding battalions cannot, however, be formed before 1909. The Landwehr and Landsturm to which men are to be transferred will have a peace strength of about 20,000, and a volunteer establishment in time of war, the militia to be increased to 12,300, to be permanently embodied, with 5,200 more to be called up for short periods; and the reorganization is being proceeded with. The total armed strength is estimated at 69,000.

The army of the Dutch East Indies numbers about 35,000 officers and men, recruited voluntarily, one-half of the men natives, and a plan of mobilization for war has recently been adopted.

PORTUGAL

The army was reorganized on October 1, 1899. The peace footing is 62,427, including 33,420 militia. The infantry of the line are 18,000, the cavalry 3,032, the dragoons 1,804, the light troops 1,012, the field artillery 3,375 and the horse artillery 479. The total number of guns is 448. The war footing is 100,264 including 52,675 militia.

A new law was introduced in September, 1895, by which the service is three years with the colors, five with the first reserve and four with the second. There is in addition a colonial army of 9,000. The rules of exemption are most liberal, a sum of money paid to the Government being accepted as an equivalent.

ROUMANIA.

The armed forces of Roumania consist of the Regular Army, the Militia, and the Opoltchénie. In peace time there only exist cadres for the regular army, which is divided into permanent and territorial troops. The period of service for the permanent troops is three years, and for the territorial troops five years for the infantry and four for the calvary; but in this latter force the soldier at first only puts in three months of continuous service; he is then sent to his home and called up, in his turn, for one week each month.

The effective of the army in war is as follows: Infantry: 8 rifle battalions; 34 infantry regiments (102 battalions; altogether 2,250 officers, 126,000 men, and 4,700 horses). Cavalry: 6 *Roshiori* regiments (24 squadrons, forming an independent division); 11 *Caalrashi* regiments (44 squadrons); total, 530 officers, 13,200 men, 12,100 horses. Artillery: 12 regiments (75 batteries, 450 guns; 40 ammunition columns; 2 fortress artillery regiments); total, 930 officers, 26,900 men, 22,800 horses. Engineers: 12 sapper companies, 4 telegraph, 4 pontoon, and 4 railway companies: total, 140 officers, 6,200 men, 1,500 horses. Grand total, 2,850 officers, 169,800 men, and 41,400 horses. If to these are added the transport, auxiliary troops, 32 militia regiments, etc., the numbers will amount to 7,500 officers, 314,000 men, and 65,000 horses.

RUSSIA.

The huge Russian army makes continual progress, and its varied composition and little-known development make it very difficult to describe. It may be said to consist of several armies: the European, the Caucasian, the Turkestan, and the Amur force; the first of these organized like other European armies, and the constitution of the others varying in conformity with local requirements. Moreover, the strength of each varies according to the necessities of the situation, the troops being on the

ordinary peace footing, on the higher peace establishment as in the frontier districts, or on the war footing as in Asiatic Russia. There are 13 greater military districts, the Transcaspian district, and the territorial region of the Don Cossacks. There are 25 army corps in Europe and the Caucasus, 2 in Turkestan, and 2 in the Amur district.

The peace strength has been given as follows:

	Europe and the Caucasus.	Asiatic Russia.
Infantry	627,000 men.	83,000 men.
Cavalry........	116,000 "	14,000 "
Artillery	138,000 "	15,000 "
Engineers	34,000 "	8,000 "
Army services . .	34,000 "	5,000 "
Total........	949,000 "	124,000 "

Of these forces the active army numbers 731,000 in Europe and the Caucasus, and 87,000 in Asiatic Russia. Baron von Tettau, in a volume on the Russian Army (1902), gives the peace strength, including Cossacks and Frontier Guards, as 1,100,000.

It must be understood that in regard to the preceding estimate and in what follows concerning the distribution of the Russian forces, considerable doubt exists. The troops were moved secretly in view of the war with Japan, and very various statements have been made as to the force actually available in the Far East.

An Imperial order of November 12, 1903, gave instructions for the formation of 2 new brigades.

The Cossack forces have a special constitution. Every Cossack becomes liable to serve as soon as he has completed his eighteenth year. For the first three years, which are looked on as "preparatory," his service is, however, purely local; but for the next twelve years he is considered as belonging to the "front" category. This category consists of three bans, the first of which is formed of men actually serving, and the two others of men who have been granted unlimited leave. The last five years are spent in the Reserve category. There is, however, a still further category, for which no limit of age is fixed: this comprises all able-bodied Cossacks not otherwise classified. These have to supply and maintain their own horses, besides providing their own clothing and equipment. The peace effective of the Cossacks is stated to be 65,930, with 52,400 horses, but it is probable that not more than 54,000 are permanently with the colors. The war strength is given as 182,065, including 4,275 officers, and there are 173,150 horses. This gives a percentage of 13.2 to the male population liable to Cossack service.

In the Russian Empire considerably over a million men annually attain the age for joining the army. In 1902 the number liable to serve was 1,122,000, and 315,832 were embodied in the standing army. Seventy per cent. of the men so entered are illiterates. About 5,000 enlist annually as volunteers, and 16,000 join the Cossacks. The period of liability to personal service lasts from the twenty-first to the forty-third year of age. Those who join the standing army spend five years with the colors (four in the infantry), thirteen in the reserve, and the remainder in the Opoltchénie, or militia. In some instances, however, the War Minister has power to retain men for a longer period with the colors; whilst, on the other hand, this period is shortened by one, two, three, or four years for those possessing a superior education. The Opoltchénie, which has been developed from a simple militia into a first reserve formation, now embraces two different classes: (1) Men between 21 and 43 years of age, who have never served; (2) men who have completed 5 years' service with the colors and 13 years in the reserve. The ages of the men vary between 39 and 43 years.

The Finnish Military Service Law, whereby the Finnish army has lost the independence guaranteed by treaty, was promulgated on August 1, 1901. The offices of Finnish commander-in-chief and staff have been abolished.

The war strength of the Russian forces consists of about 56,500 officers and 2,855,000 men, including 1,792,000 infantry and 196,000 cavalry. These form the active army of all classes. To these figures must be added the available reserves, estimated at 1,064,000; frontier battalions, 41,000; Cossacks, 142,000. There are besides these the Territorial Reserves, some 2,000,000 men, and the Opoltchénie, 1,300,000, which could be employed in case of emergency. Gen. Redigers, a well-known authority, estimates the trained reserve to be 2,700,000. It is expected that under new organization the Opoltchénie, or militia, in time of war will form 40 infantry divisions, 640 battalions; 20 regiments of cavalry, 80 squadrons; 80 batteries of artillery, and 20 battalions of sappers; but owing to the vast distances to be covered, and the want of railway accommodations, the mobilization of this great force would be neither easy nor rapid. In regard to the embodiment of the reserve force in the event of war, great advances have been made by the establishment of brigade commands and the organization of reserve brigades.

SERVIA.

The military forces consist of the national army and the militia (Opoltchénie).

The national army is divided into three levies: 1st, men from 20 to 30 years of age, and containing permanent cadres and a reserve; 2nd, men from 31 to 37 years; and 3rd, men from 38 to 45 years, with no constituted cadres in peace time.

The militia consists of men from 17 to 50 years of age not in the national army. No

substitution or buying off is allowed. The annual contingent is usually about 20,500 conscripts, of whom 6,000 are generally unfit for service.

The peace effective is difficult to calculate, because, for economic reasons, it is usual to send down men before their proper date for release. The units are strongest in the spring, and from then gradually dwindle away until a company barely consists of more than 10 or 15 men. The army is a species of semi-militia.

The war effective, according to official tables, the accuracy of which must be accepted with caution, amounts to 8,110 officers, 331,900 men, 420 guns, and 39,070 horses. The number of actual combatants would be about 228,000, but a very large proportion are of the 2d and 3d levies, with little or no training.

SPAIN.

Under the terms of an order of January 29, 1903, the army has been reorganized on the basis of an effective of 80,000 men; the second battalions of the infantry regiments and the fourth squadrons of the cavalry being reduced to skeleton formations. There are in all about 23,000 officers provided for the old establishment, but the supernumeraries are on half-pay, and their places are not being filled. There are eight captain-generalcies, but the eight army corps are replaced by divisions, and further reductions are being introduced. The headquarters are respectively: 1st, Madrid; 2nd, Seville; 3rd, Valentia; 4th, Barcelona; 5th, Saragossa; 6th, Burgos; 7th, Valladolid; 8th, Corunna.

The following is the constitution, by units, of the army: Infantry, 56 regiments, 20 battalions of Chasseurs, 4 African regiments, 2 regiments in the Balearic Islands, 2 regiments in the Canaries, recruiting cadres, etc. The cavalry, 28 regiments, and 3 squadrons for foreign possessions. Artillery, 13 field, 1 siege and 3 mountain regiments (all with four 6-gun batteries), 14 fortress battalions, 1 central gunnery school, 1 central remount committee, and 4 companies of artificers. The engineer corps consists of 4 regiments of sappers and miners, 1 pontoon regiment, 1 telegraph battalion, 1 railway battalion, 1 topographical brigade, 1 company of artificers, and 8 reserve depots, with 5 separate companies of sappers and miners for the Balearic Islands, etc. For recruiting purposes the Peninsula has 116 districts, the Canaries and Balearics have 2, and Ceuta and Melilla have 2. The total armed strength is estimated to be 500,000.

SWEDEN AND NORWAY.

SWEDEN.—The Swedish army underwent a reorganization in 1901, which is progressive and will have its full effect in 1914. General personal service has been adopted, with short periods with the colors: one year for service in the cavalry and artillery, and eight months for the infantry. The army will be substantially increased in strength. The 24 existing infantry regiments are to have a third battalion each, and 3 fortress regiments of similar strength are to be raised. Some of the new formations have already been brought into existence.

On a peace footing there are 2,606 officers, 1,797 non-commissioned officers, 6,947 corporals and others, 557 cadets, 7,792 volunteers, and 22,332 men, being a total of 40,031. The artillery are to receive Krupp quick-firing guns, of which the pattern is still under trial in an experimental battery. There are 4 corps of engineers. Steps are also to be taken to increase the body of reserve officers. One great object in the recent change is to give a more homogeneous character to the forces. The plans for mobilization of the reserves have been improved, and a Landsturm is being organized.

NORWAY.—The force now availabe for service beyond the frontier numbers, with officers and men, 25,109; but the total armed strength is estimated to be 38,000, There is, however, the defect that there is no reserve of the line to fill up the gaps which might arise during a war, without taking men from the militia (Landvaern). Besides the troops of the line there exists the militia or Landvaern for the defense of Norway, in case the troops of the line should be taken over to Sweden.

SWITZERLAND.

The federal forces do not constitute a standing army, the principle being that of a militia, and the liability to serve twelve years in the Elite, twelve in the Landwehr, and six in the Landsturm. During the twelve years in the Elite (ten for the cavalry) the aggregate service is 141 days in the infantry, 146 in the engineers, 160 in the cavalry, and 163 in the artillery.

The total military strength consists of: Elite (20 to 32 years of age): 96 battalions of infantry, 8 battalions of rifles, 24 squadrons of dragoons, 48 field batteries of 6 guns, 2 mountain batteries, 10 position batteries, and 12 companies of light horse. Landwehr (32 to 44 years of age): 96 battalions of infantry, 8 battalions of rifles, 24 squadrons of dragoons, 8 field batteries, and 15 position batteries. An aggregate total, in round numbers, of 200,000 men, of whom 130,000 are in the first 12 classes of the Elite, formed into 4 army corps. In addition, the Landsturm can furnish fully 300,000, giving an armed strength of 500,000, maintained at a cost of about $5,000,000 a year for a total population of 3,500,000.

TURKEY.

The Turkish military forces are organized on the territorial system, the whole empire being divided into seven territorial districts. By the recruiting law all Mussulmans are liable to military service. Christians and certain sects pay

an exemption tax. The nomad Arabs, although liable to service by law, furnish no recruits, and many Kurds evade service. The conscription therefore falls somewhat heavily on the Osmanlis, or Turks proper.

The men liable to service are divided into—(1) Nizam, or regular army, and its reserve; (2) Redif, corresponding to Landwehr; and (3) Mustahfiz, or Landsturm. There are also 660 Ilaveh battalions, mostly skeleton formations, in which men supplementary to the establishments are enrolled. Liability to service until recently commenced at twenty years of age, and lasted for twenty years—*i.e.*, with colors of the Nizam, four years; in the reserve of the Nizam, two years; in the Redif, four years in first class and four years in second class; and in the Mustahfiz, six years. An Iradé issued in November, 1903, increases the total Nizam service to nine years and the Redif service to nine years, it being estimated that this will add 250,000 men to the army. The cavalry are set down at 55,300; the artillery (174 field and 22 mountain batteries) at 54,720—1,356 guns; the engineers at 7,400; infantry, 583,200; total, 700,620. The Nizam has 320 battalions, 203 squadrons, and 248 batteries, and the Redif 374 battalions, 666 supplementary battalions (incomplete), and 48 squadrons. An irregular "Hamidieh" cavalry has been raised among the Kurds, and has 266 squadrons.

The total war strength is estimated to be: 46,400 officers, 1,531,600 men, 1,530 guns, and 109,900 horses. The Ottoman army has been trained and reorganized largely by German officers, and is composed of the best fighting material, as the war with Greece proved.

CHAPTER V.

THE RAILROADS OF THE WORLD.

In the Railroad Gazette (New York) for May 30, 1902, there appeared exhaustive tables, compiled from the Archiv für Eisenbahnwesen of Prussia, of the railroads of the world in the year 1900 and in previous years. With the help of these tables the Railroad Gazette, in its issue for June 6, makes the following comparative statements:

The mileage built in each decade has been for the world: Ten years to 1840, 4,772; 1850, 19,198; 1860, 43,160; 1870, 63,255; 1880, 101,081; 1890, 152,179; 1900, 107,421.

The mileage built before 1830, insignificant in amount, is included with the 4,772 miles credited above to the following decade.

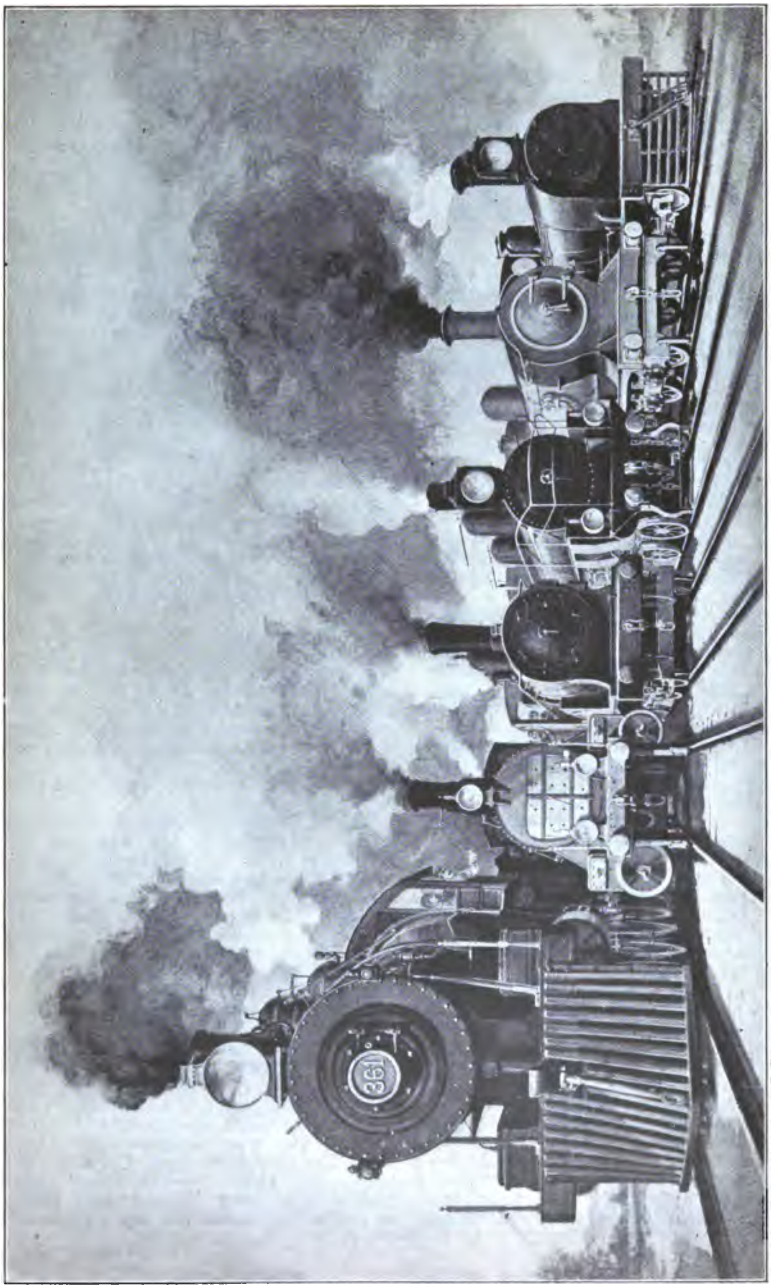
Of the total of 491,066 miles completed at the end of the century more than one-half had been built since 1880 and nearly three-fourths since 1870. The total built in the forty years down to 1870 (130.385 miles) was one-seventh less than the construction in the single decade ending with 1890. It is notable, however, that in the last decade of the century 44,758 miles less were built than in the preceding ten years. This is one of the indications that the civilized and productive industrial countries of the world are now generally well equipped with these instruments of transportation. Europe (except Russia) and North America have immediate need of no large additions to their mileage. There is still abundant room for railroads in Asia, Africa and South America, but the slow growth of industries of these continents, two of which are over rather than under populated, but whose population is to a great extent a bar to progress such as Europe and North America have had in the past century, gives no promise of rapid railroad extension.

Nevertheless, the most notable development of the last decade has been the greater activity in Asia and Africa. In Asia, until after 1890, there was scarcely any railroad except in British India, a very little in Asia Minor, a beginning in Russia and Japan. But the 20,960 miles in Asia in 1890 had become 37,477 miles in 1900, and the 6,113 miles in Africa, 12,501. The additions, considering the size of the continents, are small; but they are only beginnings, and considerable new additions have been made since 1900, chiefly the Siberian Railroad in Asia and the Uganda in Africa. It is probably not generally known that even in this last decade it is India and not Russia which leads in railroad construction in Asia; India had added 6,982 miles (42 per cent) to the 16,781 it had in 1890, while the additions in Asiatic Russia were but 4,622 miles.

In Europe more railroad was built from 1890 to 1900 than in the previous decade, but less than from 1870 to 1880. The increase in the last decade was wholly due to Russia, where it was 10,659 miles, against 4,413 miles in the previous decade. In the rest of Europe 29,700 miles were built from 1880 to 1890, and only 26,418 in the following decade.

The most notable change in the last decade, however, is the decrease in construction in North America, which was so long the great field for railroad construction. With 2,834 miles built in 1840, the increase in mileage for successive decades has been: 1840-1850, 9,099; 1850-1860, 23,644; 1860-1870, 22,887; 1870-1880, 45,629; 1880-1890, 85,766; 1890-1900, 33,856.

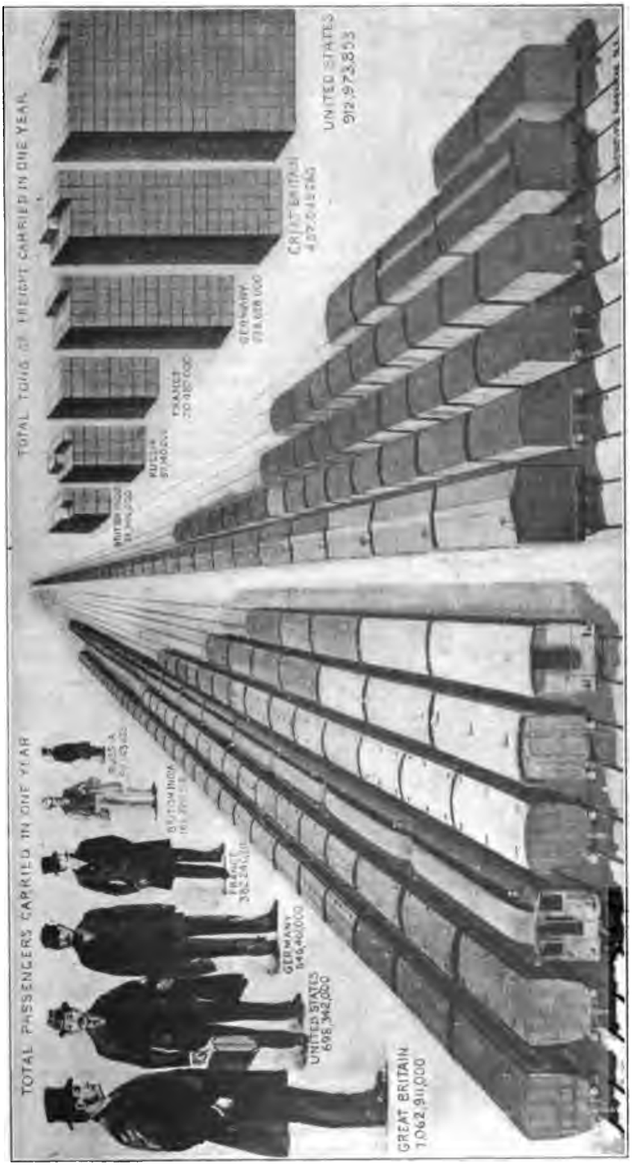
Thus the new construction on this continent in the last decade was 60 per cent less than from 1880 to 1890, and even 20 per cent less than from 1870 to 1880. The decrease in the last decade was common to Canada and Mexico, as well as to the United States. It was altogether healthy. But this country and Canada, at least, are richer to-day than they would have been if they had built as much railroad in the last decade as



United States, 184,532 miles. Germany, 29,984 miles. France, 25,862 miles. Russia in Europe, 25,357 miles. Great Britain, 23,534 miles. British India, 21,543 miles.

Magnitude of the Leading Railroad Lines of the World Represented by Size of Locomotives.

RAILWAYS OF THE WORLD COMPARED IN THE YEAR 1899.



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British India,
80,053.

Russia,
195,556.

Germany,
330,460.

France,
360,721.

Great Britain,
656,735.

United States,
1,284,807.

TOTAL NUMBER OF FREIGHT CARS.

Russia,
10,560.

British India,
14,743.

France,
28,750.

United States,
33,893.

Germany,
34,590.

Great Britain,
62,252.

TOTAL NUMBER OF PASSENGER CARS.

in the one preceding it. Fully $2,000,000,000 more than has actually been expended for new railroads would have been required: and the indications are that the capital thus saved has been most profitably employed in productive industries which give the railroads traffic to carry.

South and Central America (including West Indies) do not cut much of a figure in the railroad world, having now altogether only 29,071 miles, or less than Asia. Two-thirds of the South American mileage is in Argentina and Brazil.

Australia also has slackened its pace in railroad construction. It has room for more roads, but not people enough as yet to support them, and it grows slowly. It had 1,097 miles in 1870, added 3,780 by 1880, 6,863 more by 1890, and only 3,185 in the last decade of the century. Australia now has 14,925 miles.

The last annual return from the same source, published in June, 1903, shows the world's railroad mileage at the end of 1901.

Europe, 181,760 miles.

Mileage of Principal Countries.		Mileage of Principal Countries.	
Germany	32,943	Holland	2,035
Russia	32,130	Roumania	1,982
France	27,285	Turkey (including Bulgaria and Roumelia)	1,963
Austro-Hung'y	23,432	Denmark	1,917
Great Britain and Ireland	22,164	Portugal	1,492
Italy	9,881	Norway	1,313
Spain	8,447	Greece	607
Sweden	7,242	Servia	361
Belgium	4,047		
Switzerland	2,443		

Total America (North and South), 256,643 miles.

United States	198,346	Mexico	9,660
British North America	18,397	Brazil	9,248
Argentina	10,479	Chili	2,896

Total Asia, 42,057 miles.

British India	25,515	Japan	4,093
Siberia and Manchuria	5,697	Dutch Indies	1,392
		China	772

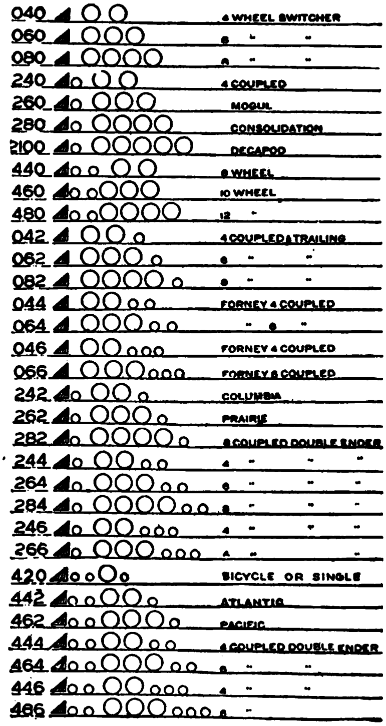
Total Africa, 14,270 miles.

British South and Central Africa	5,504	Algiers and Tunis	3,060
		Egypt	2,903

Total Australia and New Zealand, 15,470 miles.

Grand Total of World's Railroads, 510,470 miles.

TYPES OF AMERICAN LOCOMOTIVES.



—*Encyclopedia Americana.*

RAILWAY SIGNALS.

One blast of the whistle means "stop at once," or what is known as "down brakes"; two blasts of the whistle mean "off brakes"; three blasts of the whistle mean "back up"; a continuous blast means "danger." A semaphore signal at right angles to the post indicates danger; when the semaphore drops to an angle it is a signal to proceed. A red lantern indicates danger, as does a red flag; a green lantern or a green flag indicates "caution." Lanterns which are swung at right angles across the tracks mean "stop"; a lantern raised and lowered means "start"; when lanterns are swung in a circle it means "back the train."

THE RAILROAD SYSTEM OF THE UNITED STATES.*

If one were called upon to name the field of engineering in which the vast scale upon which things are done in this country is most strikingly shown, he would be safe in pointing to the colossal railroad system of the United States. In respect of the total length of track, the total number of locomotives and cars, the veritable army of employees, and the gross value of capital invested, our railway system is so huge that it stands absolutely in a class by itself among the railroad systems of the world. It is equally true that in respect of the character of its track, rolling stock, its general equipment, and methods of operation, it is marked by national characteristics which distinguish it far more sharply from the great European and Asiatic roads, than they are distinguished from each other.

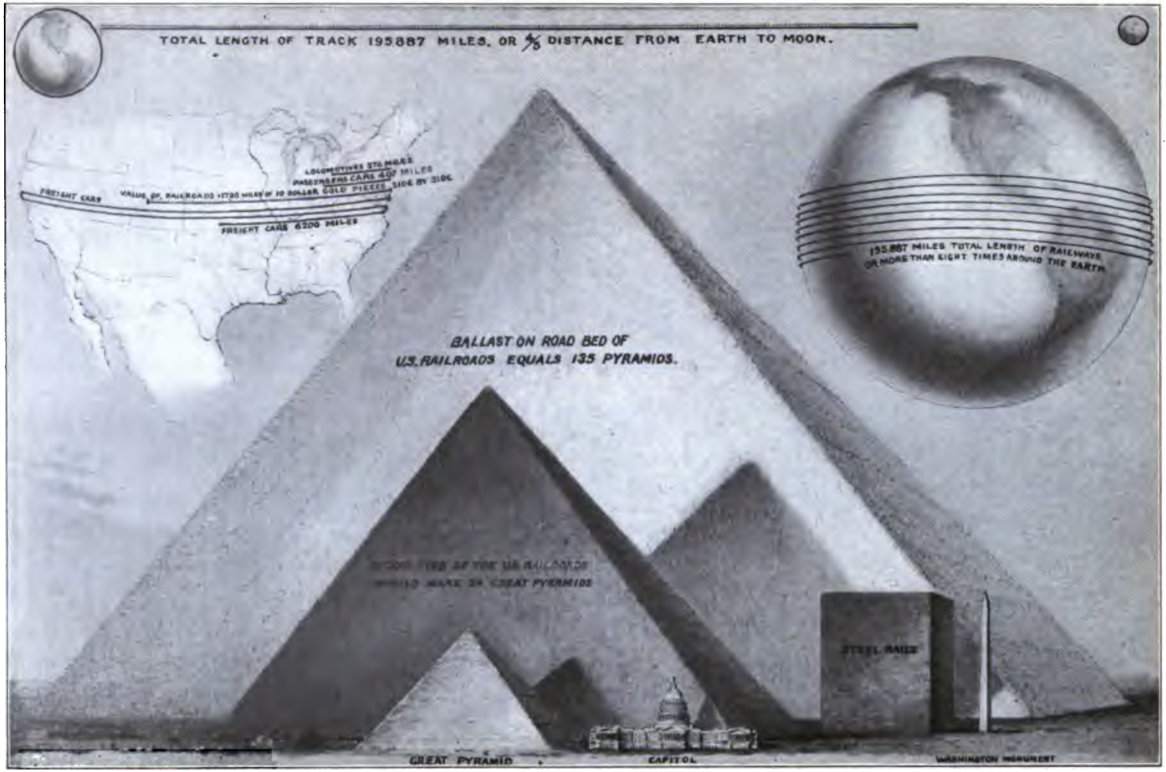
In attempting to impress upon the mind the magnitude of the properties and the operations represented by the statistics of such huge interests as the railroads of the United States, where the figures run into the millions and billions, it is necessary to translate these figures into concrete terms and refer them to some widely known standard of measurement, whether of distance, weight, or bulk. On the following pages, our artist has endeavored —and we think very successfully—to transform the statistics of our railroads into concrete form by taking as a unit of measurement the greatest single constructive work of man, the great Pyramid of Egypt, with whose dimensions every voting American citizen is perfectly familiar, or, if he is not, ought to be. From time immemorial the great Pyramid, being one of the original seven wonders of the world, has been a favorite standard of comparison with other great constructive works. It measures some 756 feet on the base by 481 feet in height, and contains about 91½ million cubic feet. Now, before we can use even this well-known standard and be sure that it will convey its full impression to the average reader, we must compare the Pyramid itself with some big and well-known structure, and for this purpose our artist has drawn the Capitol of Washington at the side of the Pyramid, both on the same scale. If it were possible to take a shell of the Pyramid, composed merely of the outer layer of stone, and place it over the Capitol, it would practically shut it out from view, and the apex of the Pyramid would extend 200 feet above the highest point of the Capitol dome.

The total length of the railroads in operation in the United States at the close of the fiscal year 1901 was 195,887 miles, this total not including track in sidings, etc. If these railroads could be stretched out in one continuous line, they would be sufficient to girdle the earth at the equator more than eight times; or, if started from the earth and stretched outward into space, they would reach four-fifths of the distance from the earth to the moon.

Steel Rails.—Now, to arrive at an estimate of what it has taken in material to build this length of railroad, let us assume that a fair average size of rail is one weighing 75 pounds to the yard. Much of the track in the Eastern States weighs 80, 90 and 100 pounds to the yard, while most of the track west of the Mississippi weighs 70, 60 and in some instances as low as 56 pounds to the yard. On this basis it is an easy calculation to determine that the total weight of these rails is over 25,000,000 tons; and if the mass were melted and cast in solid pyramidal form it would contain 105,540,000 cubic feet, and would be over 15 per cent larger than the great Pyramid itself. If the rails were cast in one rectangular block, it would form a mass 436 feet square on the base and equal in height to the Washington Monument, which towers 550 feet above its base.

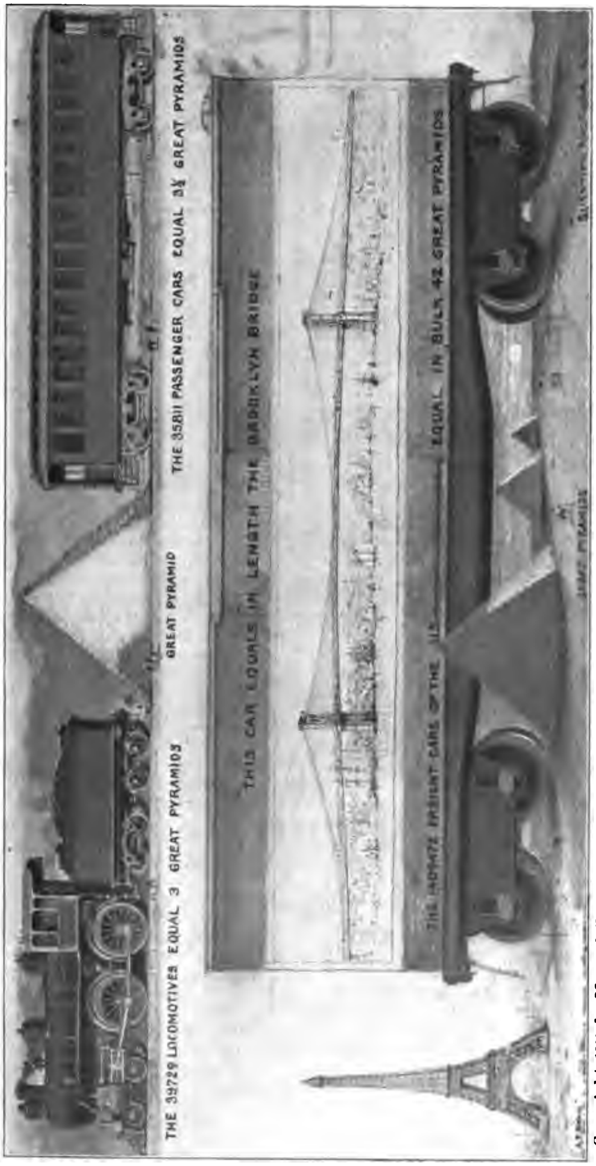
Railroad Ties.—The railroad ties used in this country vary in size from a tie 8 inches wide, 6 inches deep and 9 feet long to ties as much as 12 inches in width and 8 inches in depth. A fair average would be a tie 10 inches in width and 7 inches in depth and 9 feet long, and a good average spacing would be 24 inches, center to center of the ties, or say 2,600 to the mile. On this basis we find that, could all these ties be gathered together on the Nile desert and piled one upon another into a pyramid of the same proportions as that at Gizeh, it would form a mass twenty-four times as great as the Pyramid of the Pharaohs, measuring 2,200 feet on its base and reaching 1,390 feet into the air.

* Reprinted from the "Transportation Number" of the *Scientific American*, Dec. 13, 1902, therefore the figures and the comparisons are for that year.



Comparisons Showing Length of Railroads and Bulk of Track.

THE GREAT RAILROAD SYSTEM OF THE UNITED STATES.



Comparisons Showing Bulk of Equipment.
THE GREAT RAILROAD SYSTEM OF THE UNITED STATES.

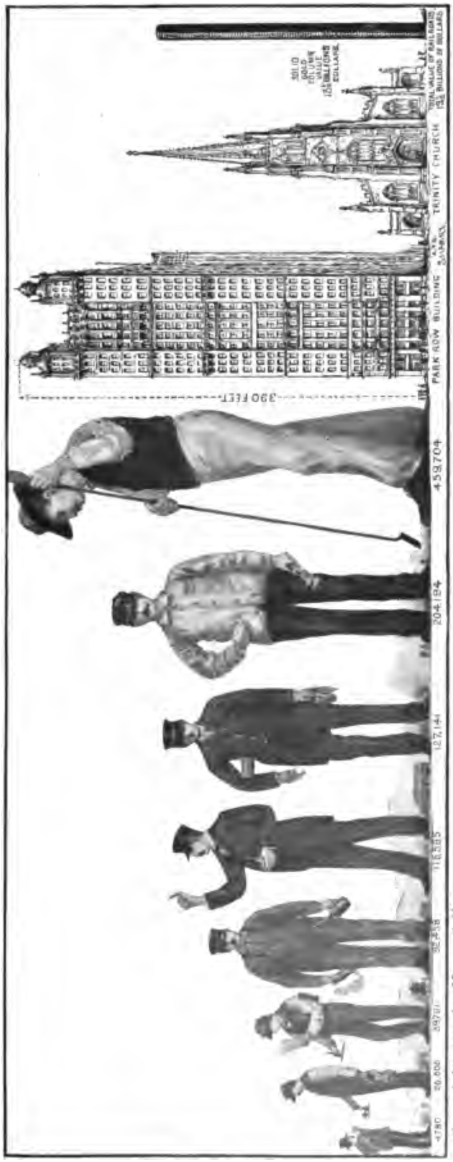
Rock and Gravel Ballast.—After the ties and rails have been laid in the construction of a railroad the ballast cars pass over it and unload their broken rock or gravel, which is tamped beneath and filled around the ties to form a solid but well-drained foundation. On some of our Eastern roads the depth of the ballast will exceed 18 or 20 inches; on the other hand, some of the Western roads have none at all, although of late years a vast advance has been made in the ballasting of the more cheaply constructed systems. Assuming an average depth of 12 inches of ballast, we find that if the railroad builders of the United States had concentrated their efforts, as did the Egyptians of old, on a single structure on the banks of the Nile, they would, in a period of years not much greater than that required to build the Pyramid, have raised a pyramid of their own 135 times greater in bulk than the tomb of Cheops. This vast pile would measure 3,900 feet on each side at the base, and would lift its head nearly half a mile into the air, or to be exact, just 2.500 feet. Were the spirit of the great Cheops to return to earth, and attempt to pace off the distance around the base, it would have to step out some 5,000 paces, or say three miles, to make the circuit; and should it climb to the summit, it would have to make a journey of about three-quarters of a mile. So much for the roadbed and the track. Now let us turn our attention to the equipment.

Locomotives.—At the close of the fiscal year 1901, there were in service on the United States railroads 39,729 locomotives. Assuming that the average locomotive fills a block 10 feet wide by 15 feet high by 50 feet long. and that all these locomotives could be brought into review at Gizeh and there piled up into one great block, a locomotive that would fill that block would be 510 feet in height and 1,700 feet, or, say, a third of a mile, in length, its smokestack towering 29 feet above the summit of the Pyramid.

Passenger Cars.—There are 35,800 passenger, mail and baggage cars on our railroads, and a typical car representing the space occupied by these would be 500 feet high and 1,950 feet in length, and it would take 3 1-2 great Pyramids to equal it in bulk.

Freight Cars.—As far as the equipment is concerned it is in the extraordinary number of the freight cars employed that we get the best idea of the great scale upon which our railroads are operated. The total number of cars is 1,409,472. They vary, of course, considerably in size, capacity and type, there being in addition to the familiar box car, the coal cars of various size and type, the freight cars, and a small number of miscellaneous cars for railroad construction and other purposes. A single box car representing the space occupied by all these freight cars would be two-thirds of a mile in length and one-quarter of a mile in height. The Pyramid of Cheops would reach about to the floor of the car. Were the Eiffel Tower set alongside of it, it would reach only two-thirds of the distance to its roof, while the whole Brooklyn Bridge, with its anchorages, could be placed bodily inside the car, and if the foundations of its piers rested upon the car floor, the summit of its towers would still reach only half way to the roof of the car.

Employees.—It requires over one million employees for the maintenance and operation of our railroads. Of these nearly one-half are engaged upon the track and roadbed, in proportions made up as follows: There are 33,817 section foremen, each of whom has a stretch of a few miles of track under his charge, and a gang of from five to eight or ten section men, his duties being those of maintaining the track in proper level and line, seeing that the track bolts are kept tight, the joints in good order, and that the roadbed is properly trimmed, graded and drained. The total number of trackmen employed in the section gangs, as they are called, is 239,166. There are also 47,576 switchmen, flagmen and watchmen, who are engaged in switching work at the yards, in guarding the level crossings, and in patrolling the track. There are also over 7,423 men employed on work trains and other work incidental to track maintenance. In addition to these there are 131,722 laborers engaged in construction and repair and maintenance work of various kinds, making a total engaged on track work and general labor connected therewith of 459.704 men. Carrying out our system of comparison with some standard of bulk, we have chosen the Park Row Building, New York, which has a total height of 390 feet. If this army of trackmen and laborers were combined in one typical giant, he would be some 385 feet in height and of proportionate weight and bulk. The next largest item is the



Trackmen and laborers.

Machinists and shopmen.

Station agents and stationmen.

Conductors and brakemen.

Enginemen and firemen.

Clerks, etc.

Telegraph operators.

General officers.

THE EMPLOYEES AND THE MONEY VALUE OF THE UNITED STATES RAILROADS.

machinists, of which there are 34,698, the carpenters, of which there are 48,946, and various other shopmen engaged in the repair and general maintenance of the rolling stock to the number of 120,550, making a total number of skilled and unskilled men in the railroad shops of 204,194. The next largest total is that of the station agents, baggage masters, porters, etc., there being 32,294 station agents and 94,847 baggage masters, porters, etc. Then follow the conductors and brakemen, 32,000 of the former and 84,493 of the latter. There are 92,458 enginemen and firemen, 45,292 of the former and 47,166 of the latter. Employed in the general offices of the various railroad companies, in performing the vast amount of clerical work required, there are 39,701 clerks, while sheltered under the same roof is a body of men upon whom as much as or more than any other in the whole army of railroad employees falls the responsibility of the safety of trains and passengers—the telegraph operators and dispatchers, of whom there are altogether 26,606. The smallest in number, but controlling the whole of this vast organization, are the general officers, presidents, vice-presidents, treasurers, secretaries, etc., of whom there are 4.780.

Money Value.—Perhaps, after all, the most remarkable figures are those which show the total value of the railroad system of the United States, which expressed in figures is 13,308,029,032 dollars. If this sum were represented in ten-dollar gold pieces, and these pieces were set on edge, side by side, they would reach more than half way from New York to San Francisco, or 1,700 miles. Or, were this coin melted and run into a single casting, it would form a column 15 feet in diameter and 259 feet in height.

ABSTRACT OF STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1903.

From summaries which appear in the Sixteenth Statistical Report of the Interstate Commerce Commission, prepared by its statistician as the complete report for the year ending June 30, 1903, this information is obtained:

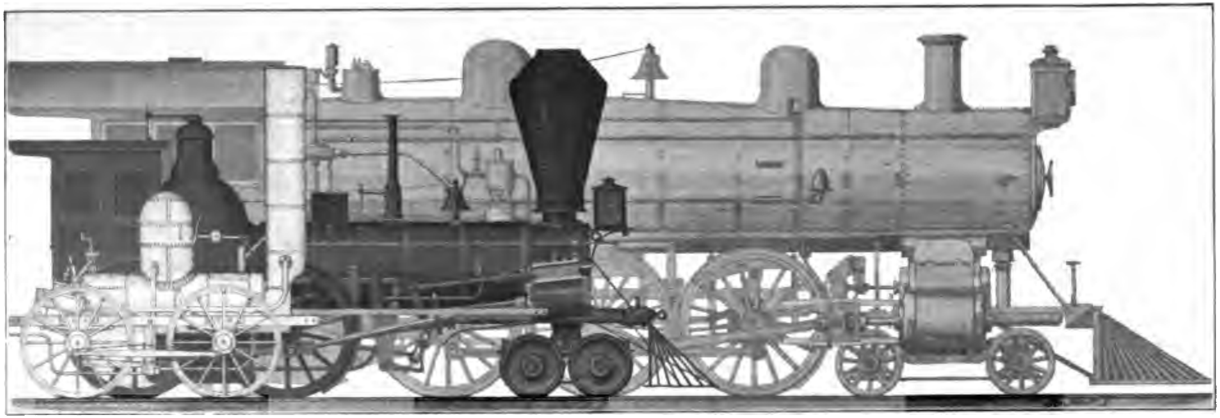
MILEAGE AND CAPITALIZATION OF ROADS.

The total single-track railway mileage in the United States on June 30, 1903, was 207,977.22 miles, having increased 5,505.37 miles in the year ending on that date. This increase exceeds that of any previous year since 1890. The nineteen states and territories for which an increase in mileage exceeding 100 miles is shown are Arkansas, California, Georgia, Illinois, Louisiana, Michigan, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, Pennsylvania, Texas, Washington, West Virginia, Wisconsin, Indian Territory, New Mexico, and Oklahoma. Most of the railway mileage of the country, excepting that of street lines, is covered by reports rendered to the Commission by the carriers.

For the year under consideration the operated mileage concerning which substantially complete returns were made was 205,313.54 miles, including 5,902.87 miles of line on which trackage privileges were exercised. The aggregate length of railway mileage, including tracks of all kinds, was 283,821.52 miles, being classified as follows: Single track, 205,313.54 miles; second track, 14,681.03 miles; third track, 1,303.53 miles; fourth track, 963,36 miles; and yard track and sidings, 61,560.06 miles. Thus it appears that there was an increase of 9.626.16 miles in the aggregate length of all tracks, of which 3,339.13 miles, or 34.69 per cent, were due to the extension of yard track and sidings.

The number of railway corporations included in the report was 2,078. Of this number 1,036 maintained operating accounts, 805 being classed as independent operating roads and 231 as subsidiary roads. Of roads operated under lease or some other form of contract, 316 received a fixed money rental, 150 a contingent money rental, and 275 were operated under conditions not readily classified. In the course of the year railway companies owning 11.074.19 miles of line were reorganized, merged, consolidated, etc. For the year 1902 the corresponding item was 7,385.99 miles.

The length of mileage operated by receivers on June 30, 1903, was 1,185.45 miles, showing a decrease of 289.87 miles as compared with the previous year. The number of roads in the hands of receivers was the same as at the close of the previous year, 9



DeWitt Clinton, 1831.	Engine of 1850.	Engine of 1902.
Cylinders, 5½x16 inches.	Cylinders, 16x20 inches.	Cylinders, 22x28 inehes
Drivers, 54 inches.	Drivers, 66 inches.	Wheels, 72 inches
Boiler pressure, 80 pounds.	Boiler Pressure, 100 pounds	Boiler pressure, 200 pounds.
Tractive effort — 919 pounds.	Tractive effort — 7,758 pounds.	Tractive effort — 32,000 pounds.

SEVENTY-ONE YEARS' GROWTH OF THE AMERICAN LOCOMOTIVE.

roads having been taken from the hands of receivers and a like number having been placed in charge of the courts.

EQUIPMENT.

On June 30, 1903, there were in the service of the railways 43,871 locomotives, the increase being 2,646. As classified, these locomotives were: Passenger, 10,570; freight, 25,444; switching, 7,058. There were also 799 not assigned to any class.

The total number of cars of all classes was 1,753,389, this total having increased 113,204 during the year. The assignment of this rolling stock was, to the passenger service, 38,140 cars; to the freight service, 1,653,782 cars; the remaining 61,467 cars being those employed directly by the railways in their own service. Cars used by the railways that were owned by private companies and firms are not included in this statement. The average number of locomotives per 1,000 miles of line was 214, showing an increase of 8. The average number of cars per 1,000 miles of line was 8,540, showing an increase of 345 as compared with the previous year. The number of passenger-miles per passenger locomotive was 1,978,786, showing an increase of 70,476 miles. The number of ton-miles per freight locomotive was 6,807,981, showing an increase of 141,482 miles as compared with June 30, 1902.

The aggregate number of locomotives and cars in the service of the railways was 1,797,260. Of this number 1,462,259 were fitted with train brakes, indicating an increase during the year of 155,414, and 1,770,558 were fitted with automatic couplers, indicating an increase of 122,028. Practically all locomotives and cars in passenger service had train brakes, and of the 10,570 locomotives in that service, 10 110 were fitted with automatic couplers. Only a few cars in passenger service were without automatic couplers. With respect to freight equipment it appears that most of the freight locomotives had train brakes and 98 per cent of them automatic couplers. Of 1,653,782 cars in freight service on June 30, 1903, 1,352,123 had train brakes and 1,632,330 automatic couplers. In this report there have been continued several summaries, first presented in the report for 1902, to show the general type of efficiency of locomotives and the capacity of freight cars.

In these summaries locomotives are classified under the heads of single-expansion locomotives, four-cylinder compound locomotives, and two-cylinder compound or cross-compound locomotives. Each of these classes of locomotives is further classified according to the number of drivers, and the number of pilot wheels and trailers.

Freight cars are first classified as box cars, flat cars, stock cars, coal cars, tank cars, refrigerator cars, and other cars. The cars in these classes are further distributed among the requisite number of subclasses, the lowest of which, Class I, being for cars having capacities in the 10,000 of pounds; Class II for cars in the 20,000 of pounds, the other classes successively increasing in the same ratio.

EMPLOYEES.

The number of persons on the pay rolls of the railways in the United States, as returned for June 30, 1903, was 1,312,537, or 639 per 100 miles of line. These figures, when compared with the corresponding ones for the year 1902, show an increase of 123,222 in the number of employees, or 45 per 100 miles of line. The classification of employees includes enginemen, 52,993; firemen, 56,041; conductors, 39,741, and other trainmen, 104,885. There were 49.961 switch tenders, crossing tenders, and watchmen. With regard to the four general divisions of railway employment it appears that general administration required the services of 45,222 employees; maintenance of way and structures, 433,648 employees; maintenance of equipment, 253,889 employees, and conducting transportation, 576,881 employees. This statement disregards a few employees of which no assignment was made.

The usual statement of the average daily compensation of the 18 classes of employees for a series of years is continued in the present report, which shows also the aggregate amount of compensation paid to more than 97 per cent of the number of employees for the year 1903 and more than 99 per cent for the six years preceding. The amount of wages and salaries paid to employees during the year ending June 30, 1903, as reported, was $757,321,415; but this amount, as compared with the total reported for the year 1902, is understated for want of returns by $18,000,000 at least.

CAPITALIZATION OF RAILWAY PROPERTY.

The par value of the amount of railway capital outstanding on June 30, 1903, was $12,599,990,258, which represents a capitalization of $63,186 per mile for the railways of the United States. Of this capital, $6,155,559,032 existed as stock, of which $4,876,961,012 was common and $1,278,598.020 preferred, and the remaining part, $6,444,431,226, as funded debt, which consisted of mortgage bonds, $5,426,730.154; miscellaneous obligations, $640,704,135; income bonds, $234,016,821, and equipment trust obligations, $142,980,116. Current liabilities are not included in railway capital for the reason that this class of indebtedness has to do with the operation rather than with the construction and equipment of a road. Current liabilities for the year amounted to $864,552,960, or $4,211 per mile of line.

Of the total capital stock outstanding, $2,704,821,163, or 43.94 per cent, paid no dividends. The amount of dividends declared during the year was $196.728,176. being equivalent to 5.70 per cent on dividend-paying stock. For the year ending June 30, 1902, the amount of dividends declared was $185,391,655. Of the total amount of stock outstanding, $6,155,559,032, 6.59 per cent paid from 1 to 4 per cent; 13.51 per cent from 4 to 5 per cent; 10.34 per cent from 5 to 6 per cent; 11.39 per cent from 6 to 7 per cent, and 9.10 per cent from 7 to 8 per cent. The amount of funded debt (omitting equipment trust obligations) that paid no interest was $272 788.421, or 4.33 per cent. Of mortgage bonds, $194,-295,524, or 3.58 per cent, of miscellaneous obligations, $7,377,925, or 1.15 per cent, and of income bonds, $71,-114,972, or 30.39 per cent, paid no interest.

PUBLIC SERVICE OF RAILWAYS.

The number of passengers reported as carried by the railways in the year ending June 30, 1903, was 694.891,535, indicating an increase of 45,013 030 as compared with the year ending June 30, 1902. The passenger-mileage, or the number of passengers carried 1 mile, was 20.915.763,881, having increased 1.225,826 261.

The number of tons of freight reported as carried (including freight received from connecting roads and other carriers) was 1,304,394,323, which exceeds the tonnage of the previous year by 104,078,536 tons. The ton-mileage, or the number of tons carried 1 mile, was 173 222,278,993, the increase being 15,932,908,940. The number of tons carried 1 mile per mile of line was 855,447, which figures indicate an increase in the density of freight traffic of 62,096 ton-miles per mile of line.

The average revenue per passenger per mile for the year mentioned was 2.006 cents, the average for the preceding year being 1.986 cents. The average revenue per ton per mile was 0.763 cent. This average for the preceding year was 0.757 cent. Earnings per train mile show an increase both for passenger and freight trains. The average cost of running a train 1 mile appears to have increased between 8 and 9 cents. The ratio of operating expenses to earnings, 66.16 per cent, also increased in comparison with the preceding year, when it was 64.66 per cent.

A summary of freight traffic, classified on the basis of a commodity classification embracing some thirty-eight items, is continued for the year under review.

EARNINGS AND EXPENSES.

The gross earnings of the railways in the United States from the operation of 205,313.54 miles of line were, for the year ending June 30, 1903, $1,900,-846,907, being $174.466,640 greater than for the previous year. Their operating expenses were $1,257,538,-852, or $141,290,105 more than in 1902. The following figures give gross earnings in detail, with the increase or the decrease of the several items as compared with the previous year: Passenger revenue, $421,704,592—increase, $28,741,344; mail, $41,709,396—increase, $1,873,552; express, $38.331,-964—increase, $4.078,505; other earnings from passenger service, $9,821,-277—increase. $962.508; freight revenue, $1,338,020,026—increase, $130,-791,181; other earnings from freight service, $4.467.025—decrease, $379,-693; other earnings from operation, including unclassified items, $46,792,-627 — increase, $8,399,243. Gross earnings from operation per mile of line averaged $9.258, the corresponding average for the year 1902 being $633 less.

The operating expenses were assigned to the four general divisions of such expenses, as follows: Mainte-

nance of way and structures, $266,421,774; maintenance of equipment, $240,429,742; conducting transportation, $702,509,818; general expenses, $47,767,947; undistributed, $409,571. Operating expenses were $6,125 per mile of line, having increased $548 per mile in comparison with the preceding year. The statistical report contains an analysis of the operating expenses for the year according to the fifty-three accounts prescribed in the official classification of these expenses, with the percentage of each item of the expenses as classified for the years 1897 to 1903.

The income from operation, or the net earnings, of the railways amounted to $643,308,055. This item, when compared with the net earnings of the year 1902, shows an increase of $33,176,535. Net earnings per mile for 1903 averaged $3,133; for 1902, $3,048, and for 1901, $2,854. The amount of income obtained from other sources than operation was $205,687,480. In this amount are included the following items: Income from lease of road, $109,696,201; dividends on stocks owned, $40,081,725; interest on bonds owned, $17,696,586, and miscellaneous income, $38,212,968. The total income of the railways, $848,995,535—that is, the income from operation and from other sources—is the amount from which fixed charges and similar items of expenditure are deducted to ascertain the sum available for dividends. Deductions of such nature totalized $552,619,490, leaving $296,376,045 as the net income for the year available for dividends or surplus.

The amount of dividends declared during the year (including $420,400, other payments from net income) was $197,148,576, leaving as the surplus from the operations of the year ending June 30, 1903, $99,227,469, that of the previous year having been $94,855,088. The amount stated above for deductions from income, $552,619,490, comprises the following items: Salaries and maintenance of organization, $430,427; interest accrued on funded debt, $283,953,124; interest on current liabilities, $9,060,645; rents paid for lease of road, $112,230,384; taxes, $57,849,569; permanent improvements charged to income account, $41,948,183; other deductions, $47,147,158.

It is perhaps appropriate to mention that the foregoing figures for the income and expenditures of the railways, being compiled from the annual returns of leased roads as well as of operating roads, necessarily include duplications in certain items of income, and also of expenditure, since, in general, the income of a leased road is the rent paid by the company which operates it.

RAILWAY ACCIDENTS.

The statement of accidents to persons in the summaries in the statistical report under consideration are presented under the two general classes of accidents resulting from the movement of trains, locomotives, or cars, and of accidents arising from causes other than those resulting from the movement of trains, locomotives, or cars. These classes include all the casualties returned by the carriers in their annual reports to the Commission, whether sustained by passengers, employees, trespassers, or other persons, and for a number of reasons they are not in all respects comparable with others in the bulletins that are based on monthly reports.

The total number of casualties to persons on the railways for the year ending June 30, 1903, was 86,393, of which 9,840 represented the number of persons killed and 76,553 the number injured. Casualties occurred among three general classes of railway employees, as follows: Trainmen, 2,070 killed and 25,676 injured; switch tenders, crossing tenders and watchmen, 283 killed, 2,352 injured; other employees, 1,253 killed, 32,453 injured. The casualties to employees coupling and uncoupling cars were, employees killed, 281; injured, 3,551. For the year 1902 the corresponding figures were, killed, 167; injured, 2,864. The casualties connected with coupling and uncoupling cars are assigned as follows: Trainmen killed, 211; injured, 3,023; switch tenders, crossing tenders and watchmen killed, 57; injured, 416; other employees killed, 13; injured, 112.

The casualties due to falling from trains, locomotives, or cars in motion were: Trainmen killed, 440; injured, 4,191; switch tenders, crossing tenders and watchmen killed, 39; injured, 461; other employees killed, 72; injured, 536. The casualties due to jumping on or off trains, locomotives, or cars in motion were: Trainmen killed, 101; injured, 3,133; switch tenders, crossing tenders and watchmen killed, 15; injured, 279; other employees killed, 82; injured, 508.

The casualties to the same three classes of employees in consequence of collisions and derailments were: Trainmen killed, 648; injured, 4,526; switch tenders, crossing tenders and watchmen killed, 17; injured, 137; other employees killed, 128; injured, 743.

The number of passengers killed in the course of the year 1903 was 355, and the number injured 8,231. In the previous year 345 passengers were killed and 6,683 injured. There were 173 passengers killed and 4,584 injured because of collisions and derailments. The total number of persons, other than employees and passengers, killed was 5,879; injured, 7,841. These figures include the casualties to persons classed as trespassing, of whom 5,000 were killed and 5,079 were injured. The total number of casualties to persons other than employees from being struck by trains, locomotives, or cars, were 4,534 killed and 4,029 injured. The casualties of this class were as follows: At highway crossings, passengers killed, 3; injured, 7; other persons killed, 895; injured, 1,474; at stations, passengers killed, 24; injured, 108; other persons killed, 390; injured, 501; at other points along track, passengers killed, 8; injured, 14: other persons killed, 3,214; injured, 1,925. The ratios of casualties indicate that 1 employee in every 364 was killed, and 1 employee in every 22 was injured. With regard to trainmen—that is, enginemen, firemen, conductors, and other trainmen—it appears that 1 trainman was killed for every 123 employed, and 1 was injured for every 10 employed.

One passenger was killed for every 1,957,441 carried, and 1 injured for every 84,424 carried. With respect to the number of miles traveled, however, the figures show that 58,917,645 passenger-miles were accomplished for each passenger killed, and 2,541,096 passenger-miles for each passenger injured.

INTERESTING FACTS CONCERNING RAILWAYS.

Differences of Gauge.—It is not really known what, if any, principle governed the determination in the first instance of the gauge between the rails of 4 ft. 8½ ins., which is the standard railway gauge of the world. It is supposed to have been adopted from the roads of the collieries in the north of England, whose uniform width necessitated the use of wagons having axles of an outside width of 5 feet. In places these wagons ran on tramways, with a flange on the outer edge of the rail. Then came the edge rail, which transferred the flange to the wheel. However, the same width of track was continued, but measured from the inner edge of the rail it gave a gauge of 4 ft. 8½ ins. When Stephenson was selected from these collieries to build the Liverpool and Manchester railway, he brought with him the gauge with which he was familiar.

The 4 ft. 8½ ins. gauge is the standard one in Europe, with but few exceptions, and in North America, and throughout the world generally, though every country possesses lines of narrower gauges. European countries having a different gauge are Ireland, 5 ft. 3 ins., Russia, 5 ft., and Spain, 5 ft. 6 ins. The standard gauge of India is 5 ft. 6 ins., while there are also a number of railways whose mileage amounts to 42 per cent. of the whole, built on the 3 ft. 3⅜ ins. gauge. In New Zealand, Tasmania, South Africa and the Sudan the standard gauge is 3 ft. 6 ins. Australia has no standard gauge. In New South Wales the gauge is 4 ft. 8½ ins., in Queensland 3 ft. 6 ins., and in Victoria, 5 ft. 3 ins.

CAPE TO CAIRO RAILWAY.

The Cape to Cairo Railway, which was the late Mr. Rhodes's scheme for joining the south and north of Africa, a distance of nearly 5,000 miles, is making rapid progress. Northwards from the Cape the line has been carried forward by the Chartered Company to the Wankie coal-fields, which are 200 miles north of Buluwayo (or 1,560 miles north from the sea), and some 70 miles south of the Victoria Falls. At the present rate of progress it is expected that the railway will reach the Victoria Falls about April, 1905. In the north the railway only runs as far as Khartoum, and in spite of the agreement with Abyssinia permitting the making of a line through its territory, no extension south is likely in the present generation.

Mr. Rhodes's idea was to fit the main lines with branches to the coast; there will be many of these in time. Two are finished, the Uganda Railway (British) and the Beira-Salisbury line (Portuguese); others are planned, such as the Congo-Katanga Railway (Belgian) to Rhodesia and one through German East Africa. The Cape to Cairo telegraph is rapidly approaching completion; it has now reached Central Africa.

TRANS-SIBERIAN RAILWAY.

The opening of the Trans-Siberian Mail route promises to accelerate the transmission of European letters to and from the north of

China. A letter posted from Tientsin on the 30th August, 1902, and forwarded by this route, was delivered in Liverpool on the 28th September—just 28 days later. The transmission of letters via Brindisi or via Vancouver usually takes from 36 to 40 days. Therefore, the Trans-Siberian Railway saves at least a week, which is a matter of great importance to commercial houses. Delivery is, however, erratic, and no working arrangement has yet been arrived at between the Post Offices of Great Britain and Russia. All that the former does is to forward letters marked "Via Siberia" by the Russian route; all others go by sea.

On Sept. 27th, 1903, the mails to the Far East were despatched from Paris (Nord) for the first time via Berlin and Moscow.

Moscow is the western terminus of the Trans-Siberian Railway, the main line of which extends thence to Dalny, a distance of 5,403 miles. The Manchuria-Dalny section, 1,171 miles, embraces the following important junctions: Harbin, for Vladivostok via Grodekovo; Tachitchiao, for Pekin via Inkoo (Newchang), and Nangaline for Port Arthur.

The most direct route from London to Moscow is via Dover, Ostend, Berlin, Alexandrowo, Warsaw, and Brest Litewski. The distance is 1,800 miles, and the through journey occupies 67 hours.

The Coast terminals of the Trans-Siberian Railway, viz., Dalny, Vladivostok, and Port Arthur, are also ports of call with various steamship companies, whose boats are arranged to connect with the train service generally. Thus, the boats of the East China Railway Company ply between Dalny and Shanghai, Dalny and Nagasaki, and Dalny, Port Arthur, and Chifu, and between Vladivostok and Shanghai. The "Oiye" (Japan) Line call at Vladivostok and sail to and from all Japanese ports. The Russian Volunteer fleet has a steamship service between Odessa and Vladivostok, calling at Singapore, Port Arthur, and Nagasaki. The "Nipon Yusen-Kaisha" Company furnish boats between Kobe, Nagasaki, Fusan, Gensan, and Vladivostok, and between Kobe, Chifu, Dalny, Port Arthur, and Taku. The Hamburg-American Line gives a service between Hongkong and Vladivostok.

Fares from London, via Dover, Ostend, and Alexandrowo:

	1st Class.	2d Class
To Dalny	$195	$135
To Pekin	200	140
To Port Arthur	200	140
To Vladivostok	185	125
To Shanghai	215	150
To Nagasaki	215	150

Trains are ferried across Lake Baikal, but the railway round the south of the lake is being built. The Manchurian Railway itself is in a very bad condition, owing to poor construction. Days and sometimes weeks of delay are common. The Siberian main line, now single, is to be doubled.

New Trans-Canadian Railway.—The Grand Trunk Railway Company has secured the assent of the Dominion Parliament to the construction of a new railroad straight across Canada, from New Brunswick in the east te the Pacific Ocean in the west. The Government will themselves be the owners of the whole line from New Brunswick to Winnipeg, but the line is to be leased to and worked by the Grand Trunk Pacific. The Grand Trunk Pacific will be restricted in its possession and ownership of the road west of Winnipeg.

Sahara Railway.—A project which is being much discussed in France is a railway across the Sahara. Three routes have been suggested, one from Igli to the Niger, one from Biskra, 214 miles southeast of Algiers, to the west shore of Lake Chad, and the third from Bizerta in Tunis to Lake Chad. M. Paul Bonnard, an expert in African affairs, recommends the latter, as it would connect the French possessions in North Africa with the French Congo, and thus become a trans-African railway.

—*Daily Mail Year Book.*

STREET AND ELECTRIC RAILWAYS IN THE UNITED STATES, 1902.

The statistics contained in this section cover all street and electric railways in the United States that were in operation during any part of the year ending June 30, 1902. The term "street and electric railways" as here used includes all electric railways irrespective of their length or location, and all street railways irrespective of their motive power. At the census of 1890 the railroads that used motive power other than steam were confined almost exclusively to urban districts and were properly classed as "street railways," but the application of electricity has enabled these roads to greatly extend their lines in rural districts, and a large proportion of the trackage is now outside the limits of cities, towns, or villages. That the use of electric power has been the principal factor in the development of these railways during the past few years is shown by the table which presents for the years 1890 and 1902, the number of companies and miles of single track in the United States, segregated according to character of motive power which is employed.

NUMBER OF COMPANIES AND MILES OF SINGLE TRACK GROUPED ACCORDING TO MOTIVE POWER: 1890 AND 1902.

CHARACTER OF POWER.	1902		1890		PER CENT OF INCREASE.	
	Number of companies.	Miles of single track.	Number of companies.	Miles of single track.	Number of companies.	Miles of single track.
United States	849	*22,589.47	761	8,123.02	11.6	178.1
Electric	747	†21,920.07	126	1,261.97	492.9	1,637.0
Animal	67	259.10	506	5,661.44	‡86.8	‡95.4
Cable	26	240.69	55	488.31	‡52.7	‡50.7
Steam	9	169.61	74	711.30	‡87.8	‡76.2

* Includes 12.48 miles of track duplicated in reports of different companies.
† Includes 6.06 miles operated by compressed air.
‡ Decrease.

At both censuses some companies reported the use of more than one kind of power, and in order to show the total number of companies for each class, they have been counted more than once; therefore the total given in table above exceeds the actual number of separate companies. The increase in the length of track is confined entirely to the roads operated by electric power. The use of electric power was reported by 126 companies in 1890 and 747 in 1902. The single track mileage operated by this power increased from 1,261.97 miles in 1890 to 21,920.07 in 1902. A decided decrease is shown in the number of companies and the trackage for each of the other classes of power.

The length of single track, 22,589.47 miles, reported for 1902, consists of 16,651.58 miles of first main track, 5,030.36 miles of second main track, and 907.53 miles of sidings and turnouts. The second table reproduces the totals for the United States and shows the mileage of each of the different classes of track and the per cent which each class forms of the total.

SINGLE-TRACK MILEAGE AND PER CENT. WHICH EACH CLASS IS OF TOTAL: 1902.

CLASS OF TRACK.	Single-track mileage.	Per cent of total.
Total	*22,589.47	100.0
First main track	16,651.58	73.7
Second main track	5,030.36	22.3
Sidings and turnouts	907.53	4.0
Overhead trolley	21.302.57	94.3
Other electric power	611.44	2.7
Compressed air	6.06	(†)
Animal	529.10	1.1
Cable	240.69	1.1
Steam	169.61	.8
Trackage owned	19,038.33	84.3
Trackage leased	3,551.14	15.7
Operated under trackage rights	560.92	2.5
Constructed and opened for operation during the year	1,549.73	6.9
On private right of way owned by company	3,424.96	15.2
On private right of way not owned by company	377.11	1.7
Located within city limits	‡13,208.24	65.8
Located outside city limits	‡6,855.58	34.2
Equipped with cast welded joints	1,642.68	7.3

* Includes 12.48 miles of track duplicated in reports of different companies.
† Less than one-tenth of 1 per cent.
‡ Exclusive of the mileage of Massachusetts.

Of the total single-track mileage, 21,914.01 miles, or 97 per cent, were operated by electric power and 416.36 miles, or 1.9 per cent, by other mechanical traction, while only 259.10 miles, or 1.1 per cent, were operated by animal power, as compared with 69.7 per cent in 1890. Of the total trackage in use by all companies, 84.3 per cent was owned by the operating companies and 15.7 per cent leased. The mileage of track constructed and opened for operation during the year covered by this report was 1,549.73 miles, or 6.9 per cent of the total, but this does not cover all of the track under construction. A number of miles of track were in various stages of completion, but it was impracticable to fix upon any stage of the work at which the trackage could be enumerated other than that of actual completion. The statistics concerning track located on private right of way refer particularly to rural electric railways, many of which have bought or have had surrendered to them a separate roadbed, either adjoining or independent of the highway, in the same manner as a steam railroad. It appears from the reports that 3,424.96 miles of single track were on private right of way owned by the company. Occasionally the railway is built on a private right of way not owned by the company, an example of which would be a toll bridge owned by a bridge company, to whom payment for the privilege of using it was made. There were 377.11 miles of single track on right of way of this character.

The inquiries concerning the location of track, whether within or without city limits, were made with the intention of ascertaining the relative length of track operated in urban and rural districts, respectively. In a number of cases it was impossible to determine exactly the trackage that should be assigned to these two subdivisions. In some instances the track was within or passed through thickly settled communities that were not organized as cities or towns, and therefore had no legal limits, and it was difficult to obtain the length that should be considered as within the urban district. In the New England states densely populated communities are legally part of the town government, which includes also rural districts. Many companies in Massachusetts reported that it was impracticable to make the distinction, and accordingly the trackage for that state has not been included in this classification. For the United States, exclusive of Massachusetts, 13,208.24 miles of single trackage, or 65.8 per cent of the total, were reported as within urban limits and 6,855.58 miles, or 34.2 per cent, as outside of such limits.

The increase in the trackage is due not only to the establishment of new companies, but very largely to the extension of the lines of established companies.

COMPANIES GROUPED ACCORDING TO LENGTH OF LINE: 1890 AND 1902.

LENGTH OF ROAD BED.	1902		1890	
	Number of companies.	Length of line.	Number of companies.	Length of line.
Total	*817	16,651.58	†691	‡5,119.53
Under 10 miles	394	1,957.16	557	2,304.49
10 to 20 miles	219	3,148.94	99	1,353.42
Over 20 to 30 miles	76	1,878.54	16	400.39
Over 30 to 40 miles	34	1,197.83	7	251.74
Over 40 to 50 miles	25	1,117.05	4	178.04
Over 50 to 60 miles	16	892.86	2	101.57
Over 60 to 70 miles	12	785.22	2	130.33
Over 70 to 80 miles	7	532.46	1	76.48
Over 80 to 90 miles	6	515.30	1	84.42
Over 90 to 100 miles	3	277.12	....	....
Over 100 miles	25	4,349.10	2	238.65

* Operating companies.
† Exclusive of 15 lessor companies.
‡ Exclusive of 663.94 miles estimated in 1890.

COMPARATIVE SUMMARY, ALL COMPANIES: 1890 AND 1902.

ITEMS.	1902	1890	Per cent of increase.
Number of companies	987	706	39.8
Cost of construction and equipment	$2,167,634,077	$389,357,289	456.7
Capital stock issued	$1,315,572,960	$289,058,133	355.1
Funded debt outstanding	$992,709,139	$189,177,824	424.7
Earnings from operation	$247,553,999	$90,617,211	173.2
Operating expenditures	$142,312,597	$62,011,185	129.5
Percentage operating expenses of earnings	57.5	68.4	......
Number of passenger cars	60,290	32,505	85.5
Number of fare passengers carried	4,809,554,438	2,023,010,202	137.7
Number of employees*	133,641	70,764	88.9

* Exclusive of salaried officials and clerks.

The "length of line" as given in the report means the length of the roadbed, or, in the case of a railway lying entirely within city limits, the length of street occupied. In determining the length of single track, switches and sidings are included, and double track is reckoned as two tracks. The increase in the length of line during the period of twelve years amounted to 11,532.05 miles, or 225.3 per cent, as compared with an increase of 14,466.45 miles, or 178.1 per cent, in the length of single track. Single-track roads are characteristic of rural districts, and the fact that the percentage of increase in length of line is greater than in length of single track is due principally to the great development of interurban single-track lines since 1890.

The average length of line per operating company in 1890 was 7.41 miles as compared with 20.38 miles in 1902. The average operating com-

RELATION OF STREET AND ELECTRIC RAILWAYS TO POPULATION 1890 AND 1902.

GEOGRAPHIC DIVISIONS.	Year.	Population.*	Total number of fare passengers carried.	Average number of rides per inhabitant.
United States	1902 1890	75,994,575 62,622,250	4,809,554,438 2,023,010,202	63 32
Increase	....	13,372,325	2,786,544,236	31
North Atlantic	1902 1890	21,046,695 17,401,545	2,618,528,979 1,141,187,460	124 66
Increase	....	3,645,150	1,477,341,519	58
South Atlantic	1902 1890	10,443,480 8,857,920	332,541,075 101,647,174	32 11
Increase	....	1,585,560	230,893,901	21
North Central	1902 1890	26,333,004 22,362,279	1,344,000,951 538,309,887	51 24
Increase	....	3,970,725	805,691,064	27
South Central	1902 1890	14,080,047 10,972,893	210,103,861 98,005,026	15 9
Increase	....	3,107,154	112,098,835	6
Western	1902 1890	4,091,349 3,027,613	304,379,572 143,860,655	74 48
Increase	....	1,063,736	160,518,917	26

* Population shown for 1902 is that reported at the census of 1900.

pany in 1902 controlled almost three times the length of line that was controlled by the average company in 1890. In 1890 there were only 8 companies operating more than 50 miles of line, and in 1902 the number of such companies had increased to 69. Of the total number of companies reported for 1890, 94.9 per cent operated less than 20 miles of line each, and their combined length of line amounted to 71.5 per cent of the total in the United States; in 1902 corresponding percentages were 75 and 30.7, respectively. Thus, while there are still a large number of companies that operate less than 20 miles of track, the portion of the total length of line operated by them is not half as great as in 1890.

The extent to which street and electric railways are used, and the increase in their use as measured by the average number of rides per inhabitant, are shown below.

From this table it appears that the most extensive use of street and electric railways is in the North Atlantic states, where the average number of rides per inhabitant in 1902 was 124; the Western states come next with an average of 74. The greatest increase in this respect is shown for the South Atlantic states, where the average was almost three times as great in 1902 as it was in 1890.

NUMBER OF OPERATING AND LESSOR COMPANIES BY STATES AND TERRITORIES: 1902.

States and Territories	Total.	Operating.	States and Territories.	Total.	Operating.
United States	987	817	Mississippi	5	5
			Missouri	17	16
Alabama	9	9	Montana	5	5
Arizona	2	2	Nebraska	4	4
Arkansas	7	7	New Hampshire	13	7
California	35	35	New Jersey	30	26
Colorado	9	8	New Mexico	1	1
Connecticut	27	23	New York	119	96
Delaware	3	3	North Carolina	7	7
District of Columbia	8	8	Ohio	67	63
Florida	6	6	Oregon	6	6
Georgia	10	10	Pennsylvania	196	98
Idaho	1	1	Rhode Island	8	8
Illinois	58	50	South Carolina	7	7
Indiana	27	27	South Dakota	1	1
Iowa	22	22	Tennessee	8	8
Kansas	12	12	Texas	17	17
Kentucky	12	12	Utah	3	3
Louisiana	8	8	Vermont	9	9
Maine	20	19	Virginia	21	21
Maryland	12	10	Washington	8	8
Massachusetts	93	75	West Virginia	8	8
Michigan	24	24	Wisconsin	17	17
Minnesota	5	5			

ACCIDENTS.—The following statement reproduces the totals concerning the number of persons killed and injured in the United States for the year 1902:

Persons.	Killed.	Injured.
Total	1,218	47,429
Passengers	265	26,690
Employees	122	3,699
Others	831	17,040

"Others" referred to in this statement, include persons on foot or riding in vehicles other than street cars who were killed or injured in collision with street cars. The number of persons reported as killed, 1,218, and injured, 47,429, form only an inappreciable percentage of the total number of passengers carried.—*From a Bulletin published by the Census Bureau.*

CHAPTER VI.

POPULATION OF THE UNITED STATES.

The population of the United States, according to the Twelfth Census, was 75,994,575, divided as follows: 38,816,448 males, 37,178,127 females. Of the total, 65,653,299 were native born, and 10,341,276 foreign born. The population is again divided as follows: White, 66,809,196; negroes, 8,833,994; Indians 237,196, but this figure does not include the population of Indian territory or on Indian reservations; Chinese, 89,863; Japanese, 24,326.

POPULATION OF EACH STATE AND TERRITORY OF THE UNITED STATES.

States and Territories.	1790.	1800.	1860.	1880.	1890.	1900.
Alabama			964,201	1,262,505	1,513,017	1,828,697
Alaska					32,052	63,592
Arizona				40,440	59,620	122,931
Arkansas			435,450	802,525	1,128,179	1,311,564
California			379,994	864,694	1,208,130	1,485,053
Colorado			34,277	194,327	412,198	539,700
Connecticut	237,946	251,002	460,147	622,700	746,258	908,420
Delaware	59,096	64,273	112,216	146,608	168,493	184,735
District of Columbia		14,093	75,080	177,624	230,392	278,718
Florida			140,424	269,493	391,422	528,542
Georgia	82,548	162,686	1,057,286	1,542,180	1,837,353	2,216,331
Idaho				32,610	84,385	161,772
Illinois			1,711,951	3,077,871	3,826,351	4,821,550
Indiana		5,641	1,350,428	1,978,301	2,192,404	2,516,462
Indian Territory					180,182	302,060
Iowa			674,913	1,624,615	1,911,896	2,231,853
Kansas			107,206	996,096	1,427,096	1,470,495
Kentucky	73,677	220,955	1,155,684	1,648,690	1,858,635	2,147,174
Louisiana			708,002	939,946	1,118,587	1,381,625
Maine	96,540	151,719	628,279	648,936	661,086	694,466
Maryland	319,728	341,548	687,049	934,943	1,042,390	1,188,044
Massachusetts	378,787	422,845	1,231,066	1,783,085	2,238,943	2,805,346
Michigan			749,113	1,636,937	2,093,889	2,420,982
Minnesota			172,023	780,773	1,301,826	1,751,394
Mississippi		8,850	791,305	1,131,597	1,289,600	1,551,270
Missouri			1,182,012	2,168,380	2,679,184	3,106,665
Montana				39,159	132,159	243,329
Nebraska			28,841	452,402	1,058,910	1,066,300
Nevada			6,857	62,266	45,761	42,335
New Hampshire	141,885	183,858	326,073	346,991	376,530	411,588
New Jersey	184,139	211,149	672,035	1,131,116	1,444,933	1,883,669
New Mexico			93,516	119,565	153,593	195,310
New York	340,120	589,051	3,880,735	5,082,871	5,997,853	7,268,894
North Carolina	393,751	478,103	992,622	1,399,550	1,617,947	1,893,810
North Dakota			4,837	135,177	182,719	319,146
Ohio		45,365	2,339,511	3,198,062	3,672,316	4,157,545
Oklahoma					61,834	398,331
Oregon			52,465	174,768	313,767	413,563
Pennsylvania	434,373	602,365	2,906,215	4,282,891	5,258,014	6,302,115
Rhode Island	68,825	69,122	174,620	276,531	345,506	428,556
South Carolina	249,073	345,591	703,708	995,577	1,151,149	1,340,316
South Dakota					328,808	401,570
Tennessee	35,691	105,602	1,109,801	1,542,359	1,767,518	2,020,615
Texas			604,215	1,591,749	2,235,523	3,048,710
Utah			40,273	143,963	207,905	276,749

* Includes 6,394 negroes.

† Included in the population of the several States.

POPULATION OF EACH STATE AND TERRITORY OF THE UNITED STATES—*Continued.*

States and Territories.	1790.	1800.	1860	1880.	1890.	1900.
Vermont	85,425	154,465	315,098	332,286	332,422	343,641
Virginia	747,610	880,200	1,596,318	1,512,565	1,655,980	1,854,184
Washington	....	....	11,594	75,116	349,390	518,103
West Virginia	....	....	....	618,457	762,794	958,800
Wisconsin	....	....	775,881	1,315,497	1,686,880	2,069,042
Wyoming	....	....	....	20,789	60,705	92,531
Persons on public ships in the service of the United States or stationed broad	....	....	....	....	....	*91,219
Total United States,	3,929,214	5,308,483	31,443,321	50,155,783	62,622,250	75,693,734
Alaska	....	....	....	....	32,052	63,592
Hawaii	....	....	....	....	89,990	154,001
Indian Territory	....	....	....	....	180,182	302,060
Indians on Reservations	....	....	....	....	145,282	(†)
Total	....	....	....	....	....	76,303,387

*Includes 6,394 negroes

†Included in the population of the several States.

[*From Reports of the Census.*]

The figures of the Bureau of Statistics vary somewhat from those of the Census, and their table given farther on is later than the Census figures. The census of the Philippine Islands taken 1904, gives the population as 7,635,426, of which 647,740 are classified as wild and uncivilized. Luzon contains 3,798,507 persons; Panay has 743,646 people; Mindanao is fourth with 499,634 inhabitants; Jolo follows with 44,718 people, of whom only 1,270 are civilized. The population of Manila is 219,028.

OFFICIAL CENSUS OF THE UNITED STATES, BY COUNTIES, FOR 1900.

ALABAMA.

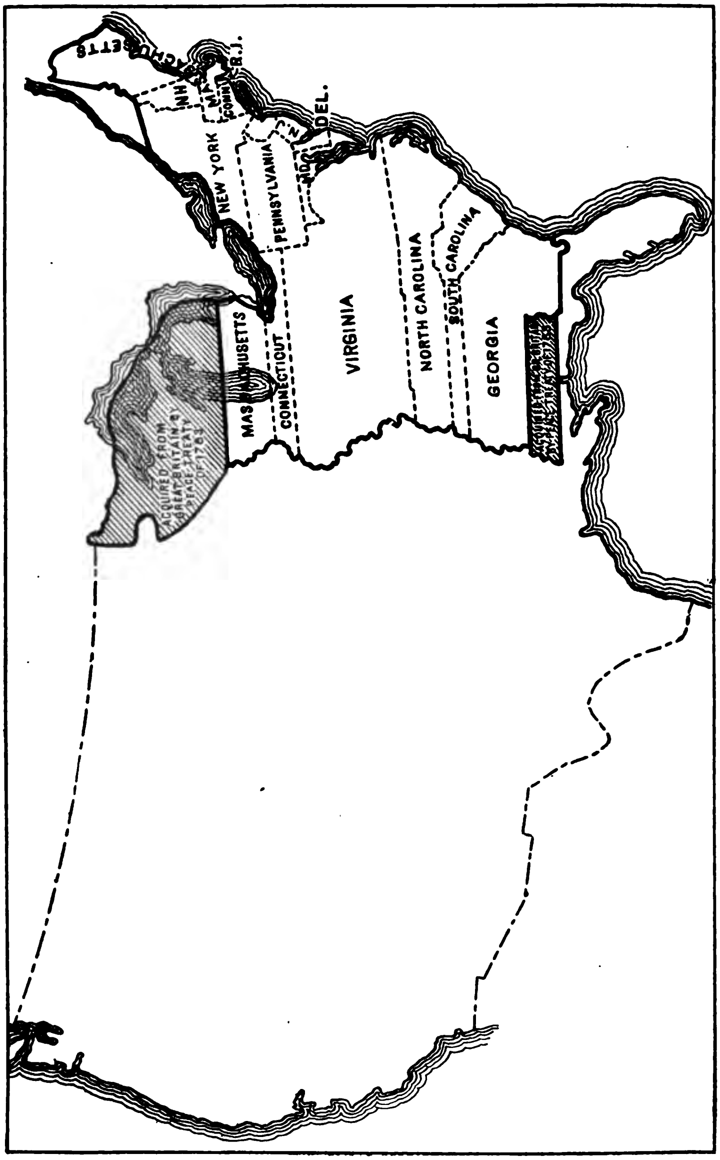
AREA, 50,722 SQUARE MILES.

Autauga	17,915	Conecuh	17,514	Jackson	30,508	Perry	31,783
Baldwin	13,194	Coosa	16,144	Jefferson	140,420	Pickens	24,402
Barbour	35,152	Covington	15,346	Lamar	16,084	Pike	29,172
Bibb	18,498	Crenshaw	19,668	Lauderdale	26,559	Randolph	21,647
Blount	23,119	Cullman	17,849	Lawrence	20,124	Russell	27,083
Bullock	31,944	Dale	21,189	Lee	31,826	St. Clair	19,425
Butler	25,761	Dallas	54,657	Limestone	22,387	Shelby	23,684
Calhoun	34,874	Dekalb	23,558	Lowndes	35,651	Sumter	32,710
Chambers	32,554	Elmore	26,099	Macon	23,126	Talladega	35,773
Cherokee	21,096	Escambia	11,320	Madison	43,702	Tallapoosa	29,675
Chilton	16,522	Etowah	27,361	Marengo	38,315	Tuscaloosa	36,147
Choctaw	18,136	Fayette	14,132	Marion	14,494	Walker	25,162
Clarke	27,790	Franklin	16,511	Marshall	23,289	Washington	11,134
Clay	17,099	Geneva	19,096	Mobile	62,740	Wilcox	35,631
Cleburne	13,206	Greene	24,182	Monroe	23,666	Winston	9,554
Coffee	20,972	Hale	31,011	Montgomery	72,047		
Colbert	22,341	Henry	36,147	Morgan	28,820		
Total							1,828,697

ARIZONA.

AREA, 113,916 SQUARE MILES.

Apache	8,297	Graham	14,162	Pima	14,689	Yuma	4,145
Cochise	9,251	Maricopa	20,457	Pinal	7,779	San Carlos Indian Reserv'n.	3,065
Coconino	5,514	Mohave	3,426	Santa Cruz	4,545		
Gila	4,973	Navajo	8,829	Yavapai	13,799		
Total							122,931



THE THIRTEEN ORIGINAL STATES, WITH THE ACCESSIONS OF TERRITORY GRANTED BY THE TREATY OF 1783 WITH GREAT BRITAIN.

ARKANSAS.

AREA, 52,198 SQUARE MILES.

Arkansas	12,973	Dallas	11,518	Lee	19,409	Pope	21,715
Ashley	19,734	Desha	11,511	Lincoln	13,389	Prairie	11,875
Baxter	9,298	Drew	19,451	Little River	13,731	Pulaski	63,179
Benton	31,611	Faulkner	20,780	Logan	20,563	Randolph	17,156
Boone	16,396	Franklin	17,395	Lonoke	22,544	St. Francis	17,157
Bradley	9,651	Fulton	12,917	Madison	19,864	Saline	13,122
Calhoun	8,539	Garland	18,773	Marion	11,377	Scott	13,183
Carroll	18,848	Grant	7,671	Miller	17,558	Searcy	11,988
Chicot	14,528	Greene	16,979	Mississippi	16,384	Sebastian	36,935
Clark	21,289	Hempstead	24,101	Monroe	16,816	Sevier	16,339
Clay	15,886	Hot Spring	12,748	Montgomery	9,444	Sharp	12,199
Cleburne	9,628	Howard	14,076	Nevada	16,609	Stone	8,100
Cleveland	11,620	Independence	22,557	Newton	12,538	Union	22,495
Columbia	22,077	Izard	13,506	Ouachita	20,892	Van Buren	11,220
Conway	19,772	Jackson	18,383	Perry	7,294	Washington	34,256
Craighead	19,505	Jefferson	40,972	Phillips	26,561	White	24,864
Crawford	21,270	Johnson	17,448	Pike	10,301	Woodruff	16,304
Crittenden	14,529	Lafayette	10,594	Poinsett	7,025	Yell	22,750
Cross	11,051	Lawrence	16,491	Polk	18,352		

Total. 1,311,564

CALIFORNIA.

AREA, 188,981 SQUARE MILES.

Alameda	130,197	Lake	6,017	Plumas	4,657	Shasta	17,318
Alpine	509	Lassen	4,511	Riverside	17,897	Sierra	4,017
Amador	11,116	Los Angeles	170,298	Sacramento	45,915	Siskiyou	16,962
Butte	17,117	Madera	6,364	San Benito	6,633	Solano	24,143
Calaveras	11,200	Marin	15,702	San Bernar-		Sonoma	38,480
Colusa	7,364	Mariposa	4,720	dino.	27,929	Stanislaus	9,550
Contra Costa	18,046	Mendocino	20,465	San Diego	35,090	Sutter	5,885
Del Norte	2,408	Merced	9,215	San Francisco	342,782	Tehama	10,996
Eldorado	8,986	Modoc	5,076	San Joaquin	35,452	Trinity	4,383
Fresno	37,862	Mono	2,167	San Luis Obis-		Tulare	18,375
Glenn	5,150	Monterey	19,380	po	16,637	Tuolumne	11,166
Humboldt	27,104	Napa	16,451	San Mateo	12,094	Ventura	14,367
Inyo	4,377	Nevada	17,789	Santa Barbara	18,934	Yolo	13,618
Kern	16,480	Orange	19,696	Santa Clara	60,216	Yuba	8,620
Kings	9,871	Placer	15,786	Santa Cruz	21,512		

Total. 1,485,053

COLORADO.

AREA, 104,500 SQUARE MILES.

Arapahoe	153,017	Elbert	3,101	Las Animas	21,840	Rio Blanco	1,690
Archuleta	2,117	El Paso	31,602	Lincoln	926	Rio Grande	4,080
Baca	759	Fremont	15,636	Logan	3,292	Routt	3,661
Bent	3,049	Garfield	5,835	Mesa	9,267	Saguache	3,853
Boulder	21,544	Gilpin	6,690	Mineral	1,913	San Juan	2,342
Chaffee	7,085	Grand	741	Montezuma	3,058	San Miguel	5,379
Cheyenne	501	Gunnison	5,331	Montrose	4,535	Sedgwick	971
Clear Creek	7,082	Hinsdale	1,609	Morgan	3,268	Summit	2,744
Conejos	8,794	Huerfano	8,395	Otero	11,522	Teller	29,002
Costilla	4,632	Jefferson	9,306	Ouray	4,731	Washington	1,241
Custer	2,937	Kiowa	701	Park	2,998	Weld	16,808
Delta	5,487	Kit Carson	1,580	Phillips	1,583	Yuma	1,729
Dolores	1,134	Lake	18,054	Pitkin	7,020		
Douglas	3,120	La Plata	7,016	Prowers	3,766		
Eagle	3,008	Larimer	12,168	Pueblo	34,448		

Total 539,700

CONNECTICUT.

AREA, 4,674 SQUARE MILES.

Fairfield	184,203	Litchfield	63,672	New Haven	269,163	Tolland	24,523
Hartford	195,415	Middlesex	41,760	New London	82,758	Windham	46,861

Total 908,355

DELAWARE.

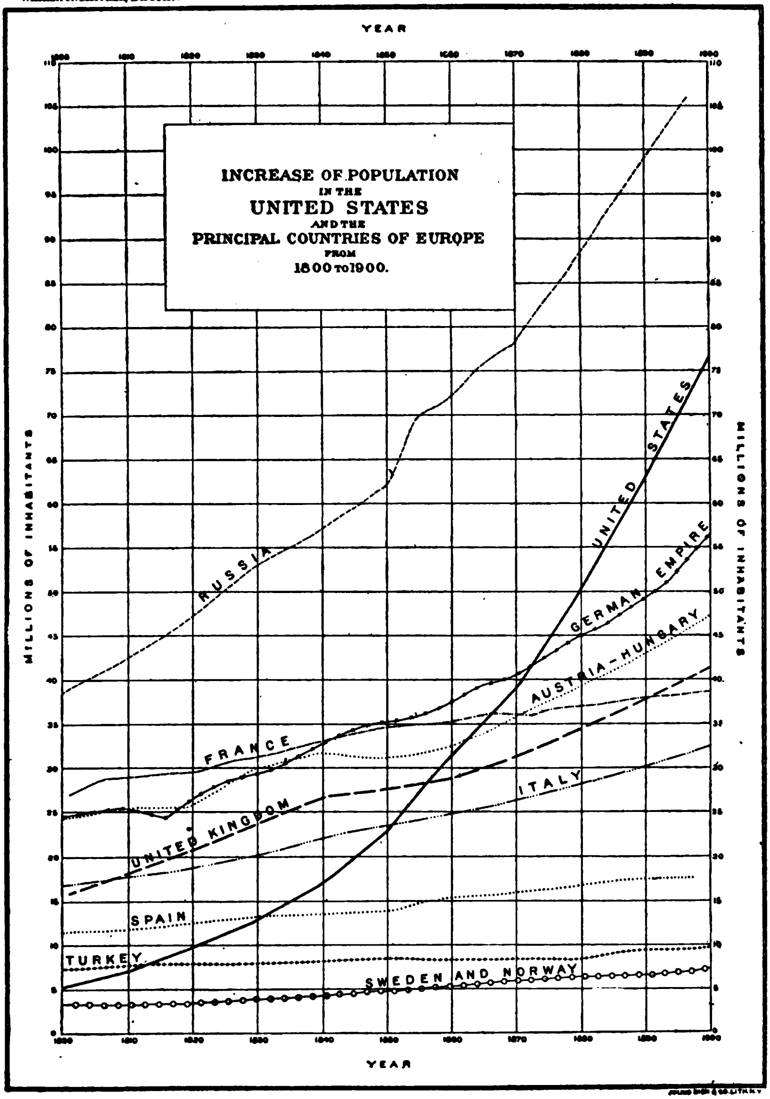
AREA, 2,120 SQUARE MILES.

Kent	32,762	Newcastle	109,697	Sussex	42,276

Total 184,735

Twelfth Census of the United States
William R. Merriam, Director.

PLATE No. 14



DISTRICT OF COLUMBIA.

AREA, 60 SQUARE MILES.

The District 278,718

FLORIDA.

AREA, 59,268 SQUARE MILES.

Alachua	32,245	Franklin	4,890	Levy	8,603	St. John	9,165
Baker	4,516	Gadsden	15,294	Liberty	2,956	Santa Rosa	10,293
Bradford	10,295	Hamilton	11,881	Madison	15,446	Sumter	6,187
Brevard	5,158	Hernando	3,638	Manatee	4,663	Suwanee	14,554
Calhoun	5,132	Hillsboro	36,013	Marion	24,403	Taylor	3,999
Citrus	5,391	Holmes	7,762	Monroe	18,006	Volusia	10,003
Clay	5,635	Jackson	23,377	Nassau	9,654	Wakulla	5,149
Columbia	17,094	Jefferson	16,195	Orange	11,374	Walton	9,346
Dade	4,955	Lafayette	4,987	Osceola	3,444	Washingon	10,154
De Soto	8,047	Lake	7,467	Pasco	6,054		
Duval	39,733	Lee	3,071	Polk	12,472		
Escambia	28,313	Leon	19,887	Putnam	11,641		

Total 528,542

GEORGIA.

AREA, 58,000 SQUARE MILES.

Appling	12,336	Dekalb	21,112	Johnson	11,409	Richmond	53,735
Baker	6,704	Dodge	13,975	Jones	13,358	Rockdale	7,515
Baldwin	17,768	Dooly	26,567	Laurens	25,908	Schley	5,499
Banks	10,545	Dougherty	13,679	Lee	10,344	Screven	19,252
Bartow	20,823	Douglas	8,745	Liberty	13,093	Spalding	17,619
Berrien	19,440	Early	14,828	Lincoln	7,156	Stewart	15,856
Bibb	50,473	Echols	3,209	Lowndes	20,036	Sumter	26,212
Brooks	18,606	Effingham	8,334	Lumpkin	7,433	Talbot	12,197
Bryan	6,122	Elbert	19,729	McDuffie	9,804	Taliaferro	7,912
Bulloch	21,377	Emanuel	21,279	McIntosh	6,537	Tattnall	20,419
Burke	30,165	Fannin	11,214	Macon	14,093	Taylor	9,846
Butts	12,805	Fayette	10,114	Madison	13,224	Telfair	10,083
Calhoun	9,274	Floyd	33,113	Marion	10,080	Terrell	19,023
Camden	7,669	Forsyth	11,550	Meriwether	23.339	Thomas	31,076
Campbell	9,518	Franklin	17,700	Miller	6,319	Towns	4,748
Carroll	26,576	Fulton	117,363	Milton	6,763	Troup	24,002
Catoosa	5,823	Gilmer	10,198	Mitchell	14,767	Twiggs	8,716
Charlton	3,592	Glascock	4,516	Monroe	20,682	Union	8,481
Chatham	71,239	Glynn	14,317	Montgomery	16,359	Upson	13,670
Chattahoochee	5,790	Gordon	14,119	Morgan	15,813	Walker	15,661
Chattooga	12,952	Greene	16,542	Murray	8,623	Walton	20,942
Cherokee	15,243	Gwinnett	25,585	Muscogee	29,836	Ware	13,761
Clarke	17,708	Habersham	13,604	Newton	16,734	Warren	11,463
Clay	8,568	Hall	20,752	Oconee	8,602	Washington	28,227
Clayton	9,598	Hancock	18,277	Oglethorpe	17,881	Wayne	9,449
Clinch	8,732	Haralson	11,922	Paulding	12,969	Webster	6,618
Cobb	24,664	Harris	18,009	Pickens	8,641	White	5,912
Coffee	16,169	Hart	14,492	Pierce	8,100	Whitfield	14,509
Colquitt	13,636	Heard	11,177	Pike	18,761	Wilcox	11,097
Columbia	10,653	Henry	18,602	Polk	17,856	Wilkes	20,866
Coweta	24,980	Houston	22,641	Pulaski	18,489	Wilkinson	11,440
Crawford	10,368	Irwin	13,645	Putnam	13,436	Worth	18,664
Dade	4,578	Jackson	24,039	Quitman	4,701		
Dawson	5,442	Jasper	15,033	Rabun	6,285		
Decatur	29,454	Jefferson	18,212	Randolph	16,847		

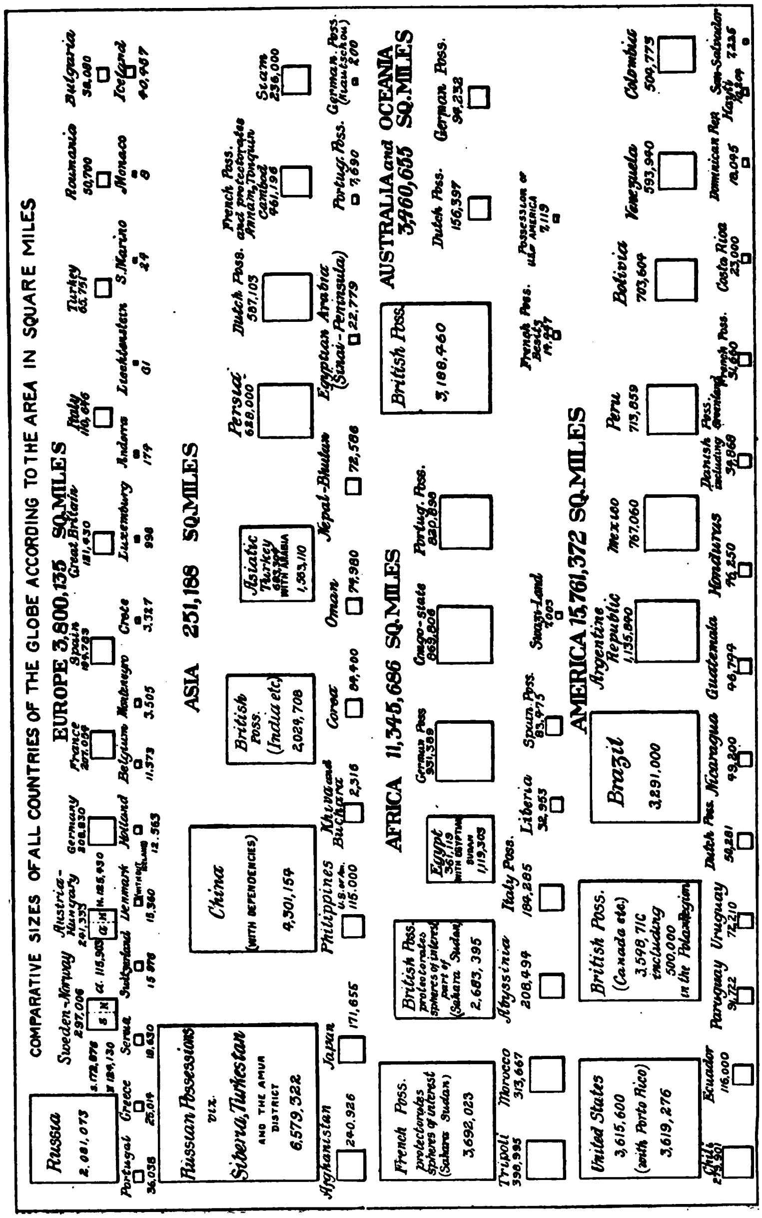
Total 2,216,331

IDAHO.

AREA, 86,294 SQUARE MILES.

Ada	11,559	Canyon	7,497	Kootenai	10,216	Owyhee	3,804
Bannock	11,702	Cassia	3,951	Latah	13,451	Shoshone	11,950
Bear Lake	7,051	Custer	2,049	Lemhi	3,446	Washington	6,882
Bingham	10,447	Elmore	2,286	Lincoln	1,784		
Blaine	4,900	Fremont	12,821	Nez Perces	13,748		
Boise	4,174	Idaho	9,121	Oneida	8,933		

Total 161,772



AREA OF THE COUNTRIES OF THE WORLD.

ILLINOIS.

AREA, 55,405 SQUARE MILES.

Adams	67,058	Ford	18,359	Livingston	42,035	Randolph	28,001
Alexander	19,384	Franklin	19,675	Logan	28,680	Richland	16,391
Bond	16,078	Fulton	46,201	McDonough	28,412	Rock Island	55,249
Boone	15,791	Gallatin	15,836	McHenry	29,759	St. Clair	86,685
Brown	11,557	Greene	23,402	McLean	67,843	Saline	21,685
Bureau	41,112	Grundy	24,136	Macon	44,003	Sangamon	71,593
Calhoun	8,917	Hamilton	20,197	Macoupin	42,256	Schuyler	16,129
Carroll	18,963	Hancock	32,215	Madison	64,694	Scott	10,455
Cass	17,222	Hardin	7,448	Marion	30,446	Shelby	32,126
Champaign	47,622	Henderson	10,836	Marshall	16,370	Stark	10,186
Christian	32,790	Henry	40,049	Mason	17,491	Stephenson	34,933
Clark	24,033	Iroquois	38,014	Massac	13,110	Tazewell	33,221
Clay	19,553	Jackson	33,871	Menard	14,336	Union	22,610
Clinton	19,824	Jasper	20,160	Mercer	20,945	Vermilion	65,635
Coles	34,146	Jefferson	28,133	Monroe	13,847	Wabash	12,583
Cook	1,838,735	Jersey	14,612	Montgomery	30,836	Warren	23,163
Crawford	19,240	Jo Daviess	24,533	Morgan	35,006	Washington	19,526
Cumberland	16,124	Johnson	15,667	Moultrie	15,224	Wayne	27,626
Dekalb	31,756	Kane	78,792	Ogle	29,129	White	25,386
Dewitt	18,972	Kankakee	37,154	Peoria	88,608	Whiteside	34,710
Douglas	19,097	Kendall	11,467	Perry	19,830	Will	74,764
Dupage	28,196	Knox	43,612	Piatt	17,706	Williamson	27,796
Edgar	28,273	Lake	34,504	Pike	31,595	Winnebago	47,845
Edwards	10,345	Lasalle	87,776	Pope	13,585	Woodford	21,822
Effingham	20,465	Lawrence	16,523	Pulaski	14,554		
Fayette	28,065	Lee	29,894	Putnam	4,746		

Total. 4,821,550

INDIANA.

AREA, 33,809 SQUARE MILES.

Adams	22,232	Franklin	16,388	Lawrence	25,729	Rush	20,148
Allen	77,270	Fulton	17,453	Madison	70,470	St. Joseph	58,881
Bartholomew	24,594	Gibson	30,099	Marion	197,227	Scott	8,307
Benton	13,123	Grant	54,693	Marshall	25,119	Shelby	26,491
Blackford	17,213	Greene	28,530	Martin	14,711	Spencer	22,407
Boone	26,321	Hamilton	29,914	Miami	28,344	Starke	10,431
Brown	9,727	Hancock	19,189	Monroe	20,873	Steuben	15,219
Carroll	19,953	Harrison	21,702	Montgomery	29,388	Sullivan	26,005
Cass	34,545	Hendricks	21,292	Morgan	20,457	Switzerland	11,840
Clark	31,835	Henry	25,088	Newton	10,448	Tippecanoe	38,659
Clay	34,285	Howard	28,575	Noble	23,533	Tipton	19,116
Clinton	28,202	Huntington	28,901	Ohio	4,724	Union	6,748
Crawford	13,476	Jackson	26,633	Orange	16,854	Vanderburg	71,769
Daviess	29,914	Jasper	14,292	Owen	15,149	Vermilion	15,252
Dearborn	22,194	Jay	26,818	Parke	23,000	Vigo	62,035
Decatur	19,518	Jefferson	22,913	Perry	18,778	Wabash	28,235
Dekalb	25,711	Jennings	15,757	Pike	20,486	Warren	11,371
Delaware	49,624	Johnson	20,223	Porter	19,175	Warrick	22,329
Dubois	20,357	Knox	32,746	Posey	22,333	Washington	19,409
Elkhart	45,052	Kosciusko	29,109	Pulaski	14,033	Wayne	38,970
Fayette	13,495	Lagrange	15,284	Putnam	21,478	Wells	23,449
Floyd	30,118	Lake	37,892	Randolph	28,653	White	19,138
Fountain	21,446	Laporte	38,386	Ripley	19,881	Whitley	17,328

Total. 2,516,492

IOWA.

AREA, 50,914 SQUARE MILES.

Adair	16,192	Calhoun	18,569	Dallas	23,058	Greene	17,820
Adams	13,601	Carroll	20,319	Davis	15,620	Grundy	13,757
Allamakee	18,711	Cass	21,274	Decatur	18,115	Guthrie	18,729
Appanoose	25,927	Cedar	19,371	Delaware	19,185	Hamilton	19,514
Audubon	13,626	Cerro Gordo	20,672	Des Moines	35,989	Hancock	13,752
Benton	25,177	Cherokee	16,570	Dickinson	7,995	Hardin	22,794
Blackhawk	32,399	Chickasaw	17,037	Dubuque	56,403	Harrison	25,597
Boone	28,200	Clarke	12,440	Emmet	9,936	Henry	20,022
Bremer	16,305	Clay	13,401	Fayette	29,845	Howard	14,512
Buchanan	21,427	Clayton	27,750	Floyd	17,754	Humboldt	12,667
Buena Vista	16,975	Clinton	43,832	Franklin	14,996	Ida	12,327
Butler	17,955	Crawford	21,685	Fremont	18,546	Iowa	19,544

IOWA—*Continued.*

Jackson	23,615	Mahaska	34,273	Plymouth	22,209	Union	19,928
Jasper	26,976	Marion	24,159	Pocahontas	15,339	Van Buren	17,354
Jefferson	17,437	Marshall	29,991	Polk	82,624	Wapello	35,426
Johnson	24,817	Mills	16,764	Pottawattamie	54,336	Warren	20,376
Jones	21,954	Mitchell	14,916	Poweshiek	19,414	Washington	20,718
Keokuk	24,979	Monona	17,980	Ringgold	15,325	Wayne	17,491
Kossuth	22,720	Monroe	17,985	Sac	17,639	Webster	31,757
Lee	39,719	Montgomery	17,803	Scott	51,558	Winnebago	12,725
Linn	55,392	Muscatine	28,242	Shelby	17,932	Winneshiek	23,731
Louisa	13,516	O'Brien	16,985	Sioux	23,337	Woodbury	54,610
Lucas	16,126	Osceola	8,725	Story	23,159	Worth	10,887
Lyon	13,165	Page	24,187	Tama	24,585	Wright	18,227
Madison	17,710	Palo Alto	14,354	Taylor	18,784		
Total							2,231,853

KANSAS.

AREA, 78,418 SQUARE MILES.

Allen	19,507	Finney	3,469	Logan	1,962	Rooks	7,960
Anderson	13,938	Ford	5,497	Lyon	25,074	Rush	6,134
Atchison	28,606	Franklin	21,354	McPherson	21,421	Russell	8,489
Barber	6,594	Geary	10,744	Marion	20,676	Saline	17,076
Barton	13,784	Gove	2,441	Marshall	24,355	Scott	1,098
Bourbon	24,712	Graham	5,173	Meade	1,581	Sedgwick	44,037
Brown	22,369	Grant	422	Miami	21,641	Seward	822
Butler	23,363	Gray	1,264	Mitchell	14,647	Shawnee	53,727
Chase	8,246	Greeley	493	Montgomery	29,039	Sheridan	3,819
Chautauqua	11,804	Greenwood	16,196	Morris	11,967	Sherman	3,341
Cherokee	42,694	Hamilton	1,426	Morton	304	Smith	16,384
Cheyenne	2,640	Harper	10,310	Nemaha	20,376	Stafford	9,829
Clark	1,701	Harvey	17,591	Neosho	19,254	Stanton	327
Clay	15,833	Haskell	457	Ness	4,535	Stevens	620
Cloud	18,071	Hodgeman	2,032	Norton	11,325	Sumner	25,631
Coffey	16,643	Jackson	17,171	Osage	23,659	Thomas	4,112
Comanche	1,619	Jefferson	17,533	Osborne	11,844	Trego	2,722
Cowley	30,156	Jewell	19,420	Ottawa	11,182	Wabaunsee	12,813
Crawford	38,809	Johnson	18,104	Pawnee	5,084	Wallace	1,178
Decatur	9,234	Kearny	1,107	Phillips	14,442	Washington	21,963
Dickinson	21,816	Kingman	10,663	Pottawatomie	18,470	Wichita	1,197
Doniphan	15,079	Kiowa	2,365	Pratt	7,085	Wilson	15,621
Douglas	25,096	Labette	27,387	Rawlins	5,241	Woodson	10,022
Edwards	3,682	Lane	1,563	Reno	29,027	Wyandotte	73,227
Elk	11,443	Leavenworth	40,940	Republic	18,248		
Ellis	8,626	Lincoln	9,886	Rice	14,745		
Ellsworth	9,626	Linn	16,689	Riley	13,828		
Total							1,470,495

KENTUCKY.

AREA, 37,680 SQUARE MILES.

Adair	14,888	Casey	15,144	Greenup	15,432	Letcher	9,172
Allen	14,657	Christian	37,962	Hancock	8,914	Lewis	17,868
Anderson	10,051	Clark	16,694	Hardin	22,937	Lincoln	17,059
Ballard	10,761	Clay	15,364	Harlan	9,838	Livingston	11,354
Barren	23,197	Clinton	7,871	Harrison	18,570	Logan	25,994
Bath	14,734	Crittenden	15,191	Hart	18,390	Lyon	9,319
Bell	15,701	Cumberland	8,962	Henderson	32,907	McCracken	28,733
Boone	11,170	Daviess	38,667	Henry	14,620	McLean	12,448
Bourbon	18,069	Edmonson	10,080	Hickman	11,745	Madison	25,607
Boyd	18,834	Elliott	10,387	Hopkins	30,995	Magoffin	12,006
Boyle	13,817	Estill	11,669	Jackson	10,561	Marion	16,290
Bracken	12,137	Fayette	42,071	Jefferson	232,549	Marshall	13,692
Breathitt	14,322	Fleming	17,074	Jessamine	11,925	Martin	5,780
Breckinridge	20,534	Floyd	15,552	Johnson	13,730	Mason	20,446
Bullitt	9,602	Franklin	20,852	Kenton	63,591	Meade	10,533
Butler	15,896	Fulton	11,546	Knott	8,704	Menifee	6,818
Caldwell	14,510	Gallatin	5,163	Knox	17,372	Mercer	14,426
Calloway	17,633	Garrard	12,042	Larue	10,764	Metcalf	9,978
Campbell	54,223	Grant	13,239	Laurel	17,592	Monroe	13,053
Carlisle	10,195	Graves	33,204	Lawrence	19,612	Montgomery	12,034
Carroll	9,825	Grayson	19,878	Lee	7,988	Morgan	12,792
Carter	20,228	Green	12,255	Leslie	6,753	Muhlenberg	20,741

KENTUCKY—*Continued.*

Nelson	16,587	Pike	22,686	Shelby	18,340	Warren	29,970
Nicholas	11,952	Powell	6,443	Simpson	11,624	Washington	14,182
Ohio	27,287	Pulaski	31,293	Spencer	7,406	Wayne	14,892
Oldham	7,078	Robertson	4,900	Taylor	11,075	Webster	20,097
Owen	17,553	Rockcastle	12,416	Todd	17,371	Whitley	25,015
Owsley	6,874	Rowan	8,277	Trigg	14,073	Wolfe	8,764
Pendleton	14,947	Russell	9,695	Trimble	7,272	Woodford	13,134
Perry	8,276	Scott	18,076	Union	21,326		

Total...2,147,174

LOUISIANA.

AREA, 41,255 SQUARE MILES.

Acadia	23,483	East Carroll	11,373	Ouachita	20,947	St. Tammany	13,335
Ascension	24,142	East Feliciana	20,443	Plaquemines	13,039	Tangipahoa	17,625
Assumption	21,620	Franklin	8,890	Pointe Coupee	25,777	Tensas	19,070
Avoyelles	29,701	Grant	12,902	Rapides	39,578	Terrebonne	24,464
Bienville	17,588	Iberia	29,015	Red River	11,548	Union	18,521
Bossier	24,153	Iberville	27,006	Richland	11,116	Vermilion	20,705
Caddo	44,499	Jackson	9,119	Sabine	15,421	Vernon	10,327
Calcasieu	30,428	Jefferson	15,321	St. Bernard	5,031	Washington	9,628
Caldwell	6,917	Lafayette	22,825	St. Charles	9,072	Webster	15,125
Cameron	3,952	Lafourche	28,882	St. Helena	8,479	West Baton	
Catahoula	16,351	Lincoln	15,898	St. James	20,197	Rouge	10,285
Claiborne	23,029	Livingston	8,100	St. John the		West Carroll	3,685
Concordia	13,559	Madison	12,322	Baptist	12,330	West Feliciana	15,994
De Soto	25,063	Morehouse	16,634	St. Landry	52,906	Winn	9,648
East Baton		Natchitoches	33,216	St. Martin	18,940		
Rouge	31,153	Orleans	287,104	St. Mary	34,145		

Total...1,381,625

MAINE.

AREA, 31,766 SQUARE MILES.

Androscoggin	54,242	Hancock	37,241	Oxford	32,238	Somerset	33,849
Aroostook	60,744	Kennebec	59,117	Penobscot	76,246	Waldo	24,185
Cumberland	100,689	Knox	30,406	Piscataquis	16,949	Washington	45,232
Franklin	18,444	Lincoln	19,669	Sagadahoc	20,330	York	64,885

Total...694,466

MARYLAND.

AREA, 11,124 SQUARE MILES.

Allegany	53,694	Carroll	33,860	Harford	28,269	St. Mary	18,136
Anne Arundel	40,018	Cecil	24,662	Howard	16,715	Somerset	25,923
Baltimore	90,755	Charles	18,316	Kent	18,786	Talbot	20,342
Baltimore City	508,957	Dorchester	27,962	Montgomery	30,451	Washington	45,133
Calvert	10,223	Frederick	51,920	Prince George	29,898	Wicomico	22,852
Caroline	16,248	Garrett	17,701	Queen Anne	18,364	Worcester	20,865

Total...1,190,050

MASSACHUSETTS.

AREA, 7,800 SQUARE MILES.

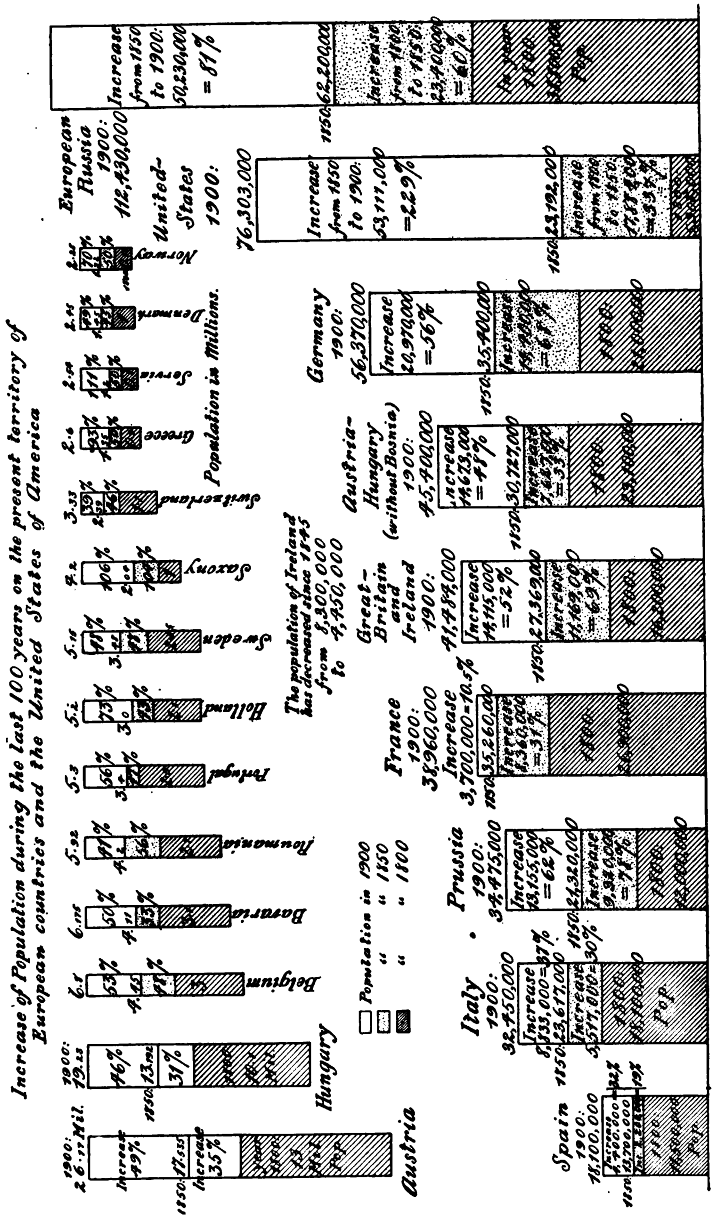
Barnstable	27,826	Essex	357,030	Middlesex	565,696	Suffolk	611,417
Berkshire	95,667	Franklin	41,209	Nantucket	3,006	Worcester	346,958
Bristol	252,029	Hampden	175,603	Norfolk	151,539		
Dukes	4,561	Hampshire	58,820	Plymouth	113,985		

Total...2,805,346

MICHIGAN.

AREA, 56,243 SQUARE MILES.

Alcona	5,691	Bay	62,378	Chippewa	21,338	Genesee	41,804
Alger	5,868	Benzie	9,685	Clare	8,360	Gladwin	6,564
Allegan	38,812	Berrien	49,165	Clinton	25,136	Gogebic	16,738
Alpena	18,254	Branch	27,811	Crawford	2,943	Grand Traverse	20,479
Antrim	16,568	Calhoun	49,315	Delta	23,881	Gratiot	29,889
Arenac	9,821	Cass	20,876	Dickinson	17,890	Hillsdale	29,865
Baraga	4,320	Charlevoix	13,956	Eaton	31,668	Houghton	66,063
Barry	22,514	Cheboygan	15,516	Emmet	15,931	Huron	34,162



INCREASE IN POPULATION.

MICHIGAN—*Continued.*

Ingham	39,818	Lenawee	48,406	Montcalm	32,754	Roscommon	1,787
Ionia	34,329	Livingston	19,664	Montmorency	3,234	Saginaw	81,222
Iosco	10,246	Luce	2,983	Muskegon	37,036	St. Clair	55,228
Irno	8,990	Mackinac	7,703	Newaygo	17,673	St. Joseph	23,889
Isabella	22,784	Macomb	33,244	Oakland	44,792	Sanilac	35,055
Jackson	48,222	Manistee	27,856	Oceana	16,644	Schoolcraft	7,889
Kalamazoo	44,310	Manitou	41,239	Ogemaw	7,765	Shiawassee	33,866
Kalkaska	7,133	Mason	18,885	Ontonagon	6,197	Tuscola	35,890
Kent	129,714	Mecosta	20,693	Osceola	17,859	Van Buren	33,274
Keweenaw	3,217	Menominee	27,046	Oscoda	1,468	Washtenaw	47,731
Lake	4,957	Midland	14,439	Otsego	6,175	Wayne	348,793
Lapeer	27,641	Missaukee	9,308	Ottawa	39,667	Wexford	16,845
Leelanau	10,556	Monroe	32,754	Presque Isle	8,821		

Total. 2,420,982

MINNESOTA.

AREA, 95,274 SQUARE MILES.

Aitkin	6,743	Freeborn	21,838	Morrison	22,891	Sibley	16,862
Anoka	11,313	Goodhue	31,137	Mower	22,335	Stearns	44,464
Becker	14,375	Grant	8,935	Murray	11,911	Steele	16,524
Beltrami	11,030	Hennepin	228,340	Nicollet	14,774	Stevens	8,721
Benton	9,912	Houston	15,400	Nobles	14,932	Swift	13,503
Bigstone	8,731	Hubbard	6,578	Norman	15,045	Todd	22,214
Blue Earth	32,263	Isanti	11,675	Olmsted	23,119	Traverse	7,573
Brown	19,787	Itasca	4,573	Ottertail	45,375	Wabasha	18,924
Carlton	10,017	Jackson	14,793	Pine	11,546	Wadena	7,921
Carver	17,544	Kanabec	4,614	Pipestone	9,264	Waseca	14,760
Cass	7,777	Kandiyohi	18,416	Polk	35,429	Washington	27,808
Chippewa	12,499	Kittson	7,889	Pope	12,577	Watonwan	11,496
Chisago	13,248	Lac qui Parle	14,289	Ramsey	170,554	Wilkin	8,080
Clay	17,942	Lake	4,654	Red Lake	12,195	Winona	35,686
Cook	810	Lesueur	20,234	Redwood	17,261	Wright	29,157
Cottonwood	12,069	Lincoln	8,966	Renville	23,693	White Earth Indian Reservation	3,486
Crow Wing	14,250	Lyon	14,591	Rice	26.080	Yellow Medicine	14,602
Dakota	21,733	McLeod	19,595	Rock	9,668		
Dodge	13,340	Marshall	15,698	Roseau	6,994		
Douglas	17,964	Martin	16,936	St. Louis	82,932		
Faribault	22,055	Meeker	17,753	Scott	15,147		
Fillmore	28,238	Millelacs	8,066	Sherburne	7,281		

Total. 1,751,394

MISSISSIPPI.

AREA, 47,156 SQUARE MILES.

Adams	30,111	Grenada	14,112	Lowndes	29,095	Sharkey	12,178
Alcorn	14,987	Hancock	11,886	Madison	32,493	Simpson	12,800
Amite	20,708	Harrison	21,002	Marion	13,501	Smith	13,055
Attala	26,248	Hinds	52,577	Marshall	27,674	Sunflower	16,084
Benton	10,510	Holmes	36,828	Monroe	31,216	Tallahatchie	19,600
Bolivar	35,427	Issaquena	10,400	Montgomery	16,536	Tate	20,618
Calhoun	16,512	Itawamba	13,544	Neshoba	12,726	Tippah	12,983
Carroll	22,116	Jackson	16,513	Newton	19,708	Tishomingo	10,124
Chickasaw	19,892	Jasper	15,394	Noxubee	30,846	Tunica	16,479
Choctaw	13,036	Jefferson	21,292	Oktibbeha	20,183	Union	16,522
Claiborne	20,787	Jones	17,846	Panola	29,027	Warren	40,912
Clarke	17,741	Kemper	20,492	Pearl River	6,697	Washington	49,216
Clay	19,563	Lafayette	22,110	Perry	14,682	Wayne	12,539
Coahoma	26,293	Lauderdale	38,150	Pike	27,545	Webster	13,619
Copiah	34,395	Lawrence	15,103	Pantotoc	18,274	Wilkinson	21,453
Covington	13,076	Leake	17,360	Prentiss	15,788	Winston	14,124
De Soto	24,751	Lee	21,956	Quitman	5,435	Yalobusha	19,742
Franklin	13,678	Leflore	23,834	Rankin	20,955	Yazoo	43,948
Greene	6,795	Lincoln	21,552	Scott	14,316		

Total. 1,551,270

MISSOURI.

AREA, 67,380 SQUARE MILES.

Adair.	21,728	Dallas.	13,903	Livingston.	22,302	Randolph	24,442
Andrew.	17,332	Daviess.	21,325	McDonald.	13,574	Ray.	24,805
Atchison.	16,501	Dekalb.	14,418	Macon.	33,018	Reynolds.	8,161
Audrain.	21,160	Dent.	12,986	Madison.	9,975	Ripley.	13,186
Barry.	25,532	Douglas	16,802	Maries.	9,616	St. Charles.	24,474
Barton.	18,253	Dunklin	21,706	Marion.	26,331	St. Clair.	17,907
Bates.	30,141	Franklin.	30,581	Mercer.	14,706	Ste.Genevieve	10,359
Benton.	16,556	Gasconade.	12,298	Miller.	15,187	St. Francois.	24,051
Bollinger.	14,650	Gentry.	20,554	Mississippi.	11,837	St. Louis.	50,040
Boone.	28,642	Greene.	52,713	Moniteau.	15,931	St. Louis City.	575,238
Buchanan.	121,838	Grundy.	17,832	Monroe.	19,716	Saline.	33,703
Butler.	16,769	Harrison.	24,398	Montgomery.	16,571	Schuyler.	10,840
Caldwell.	16,656	Henry.	28,054	Morgan.	12,175	Scotland.	13,232
Callaway.	25,984	Hickory.	9,985	New Madrid	11,280	Scott.	13,092
Camden	13,113	Holt	17,083	Newton.	27,001	Shannon.	11,247
Cape Girardeau	24,315	Howard	18,337	Nodaway.	32,938	Shelby.	16,167
Carroll.	26,455	Howell.	21,834	Oregon.	13,906	Stoddard	24,669
Carter.	6,706	Iron.	8,716	Osage.	14,096	Stone.	9,892
Cass.	23,636	Jackson.	195,193	Ozark.	12,145	Sullivan.	20,282
Cedar	16,923	Jasper.	84,018	Pemiscot.	12,115	Taney.	10,127
Chariton.	26,826	Jefferson.	25,712	Perry.	15,134	Texas.	22,192
Christian.	16,939	Johnson.	27,843	Pettis.	32,438	Vernon.	31,619
Clark.	15,383	Knox.	13,479	Phelps.	14,194	Warren.	9,919
Clay.	18,903	Laclede.	16,523	Pike	25,744	Washington.	14,263
Clinton.	17,363	Lafayette.	31,679	Platte.	16,193	Wayne.	15,309
Cole.	20,578	Lawrence.	31,662	Polk.	23,255	Webster.	16,640
Cooper.	22,532	Lewis	16,724	Pulaski.	10,394	Worth.	9,832
Crawford.	12,959	Lincoln.	18,352	Putnam.	16,688	Wright.	17,519
Dade.	18,125	Linn.	25,503	Ralls.	12,287		

Total. 3,106,665

MONTANA.

AREA, 143,776 SQUARE MILES.

Beaverhead.	5,615	Deerlodge.	17,393	Madison.	7,695	Teton.	5,080
Broadwater.	2,641	Fergus.	6,937	Meagher.	2,526	Valley.	4,355
Carbon.	7,533	Flathead.	9,375	Missoula.	13,964	Yellowstone.	6,212
Cascade.	25,777	Gallatin.	9,553	Park.	7,341	Crow Indian Reservation.	2,660
Choteau.	10,966	Granite.	4,328	Ravalli.	7,822		
Custer.	7,891	Jefferson.	5,330	Silverbow.	47,635		
Dawson.	2,443	Lewis and Clarke	19,171	Sweet Grass.	3,086		

Total 243,339

NEBRASKA.

AREA, 75,995 SQUARE MILES.

Adams.	18,840	Deuel.	2,630	Johnson.	11,197	Redwillow.	9,604
Antelope.	11,344	Dixon.	10,535	Kearney.	9,866	Richardson.	19,614
Banner.	1,114	Dodge.	22,298	Keith.	1,951	Rock.	2,809
Blaine.	603	Douglas.	140,590	Keyapaha.	3,076	Saline.	18,252
Boone.	11,689	Dundy.	2,434	Kimball.	758	Sarpy.	9,080
Boxbutte.	5,572	Fillmore.	15,087	Knox.	14,343	Saunders.	22,085
Boyd.	7,332	Franklin.	9,455	Lancaster.	64,835	Scotts Bluff.	2,552
Brown.	3,470	Frontier.	8,781	Lincoln.	11,416	Seward.	15,690
Buffalo.	20,254	Furnas.	12,373	Logan.	960	Sheridan.	6,033
Burt.	13,040	Gage.	30,051	Loup.	1,305	Sherman.	6,550
Butler.	15,703	Garfield.	2,127	McPherson	517	Sioux.	2,055
Cass.	21,330	Gosper.	5,301	Madison.	16,976	Stanton.	6,959
Cedar.	12,467	Grant.	763	Merrick.	9,255	Thayer.	14,325
Chase.	2,559	Greeley.	5,691	Nance.	8,222	Thomas.	628
Cherry.	6,541	Hall.	17,206	Nemaha.	14,952	Thurston.	8,756
Cheyenne.	5,570	Hamilton.	13,330	Nuckolls.	12,414	Valley.	7,339
Clay.	15,735	Harlan.	9,370	Otoe.	22,288	Washington.	13,086
Colfax.	11,211	Hayes.	2,708	Pawnee.	11,770	Wayne.	9,862
Cuming.	14,584	Hitchcock.	4,409	Perkins.	1,702	Webster.	11,619
Custer.	19,758	Holt.	12,224	Phelps.	10,772	Wheeler.	1,362
Dakota.	6,286	Hooker.	432	Pierce.	8,445	York.	18,205
Dawes.	6,215	Howard.	10,343	Platte.	17,747		
Dawson.	12,214	Jefferson.	15,196	Polk.	10,542		

Total. 1,068,539

NEVADA.

AREA, 122,090 SQUARE MILES.

Churchill	830	Eureka	1,954	Lyon	2,268	Washoe	9,141
Douglas	1,534	Humboldt	4,463	Nye	1,140	White Pine	1,961
Elko	5,688	Lander	1,534	Ormsby	2,893		
Esmeralda	1,972	Lincoln	3,284	Storey	3,673		

Total 42,335

NEW HAMPSHIRE.

AREA, 9,280 SQUARE MILES.

Belknap	19,526	Coos	29,468	Merrimack	52,430	Sullivan	18,009
Carroll	16,895	Grafton	40,844	Rockingham	51,118		
Cheshire	31,321	Hillsboro	112,640	Strafford	39,337		

Total 411,588

NEW JERSEY.

AREA, 3,320 SQUARE MILES.

Atlantic	46,402	Essex	359,053	Monmouth	82,057	Sussex	24,134
Bergen	78,441	Gloucester	31,905	Morris	65,156	Union	99,353
Burlington	58,241	Hudson	386,048	Ocean	19,747	Warren	37,781
Camden	107,643	Hunterdon	34,507	Passaic	155,202		
Cape May	13,201	Mercer	95,365	Salem	25,530		
Cumberland	51,193	Middlesex	79,762	Somerset	32,948		

Total 1,883,669

NEW MEXICO.

AREA, 121,201 SQUARE MILES.

Bernalillo	28,630	Grant	12,883	Rio Arriba	13,777	Socorro	12,195
Chaves	4,773	Guadalupe	5,429	San Juan	4,828	Taos	10,889
Colfax	10,150	Lincoln	4,953	San Miguel	22,053	Union	4,528
Donna Ana	10,187	Mora	10,304	Santa Fe	14,658	Valencia	13,895
Eddy	3,229	Otero	4,791	Sierra	3,158		

Total 195,310

NEW YORK.

AREA, 47,800 SQUARE MILES.

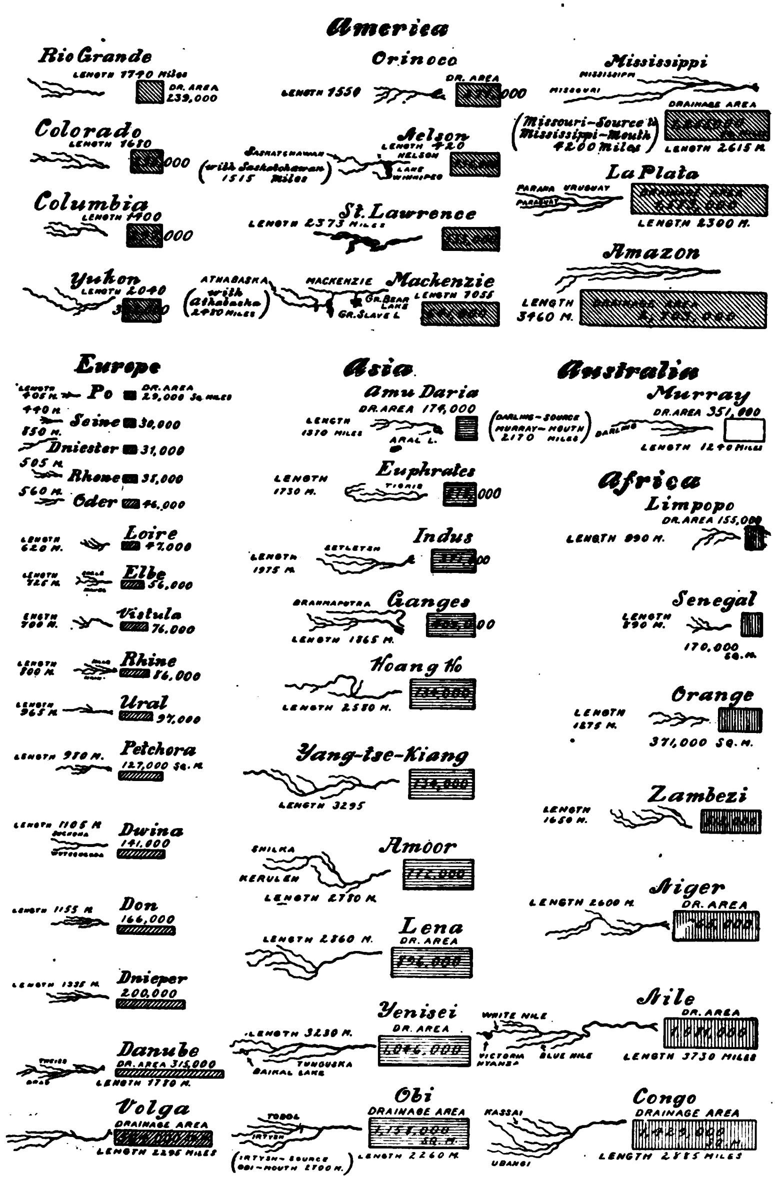
Albany	165,571	Fulton	42,842	Onondaga	168,735	Seneca	28,114
Allegany	41,501	Genesee	34,561	Ontario	49,605	Steuben	82,822
Broome	69,149	Greene	31,478	Orange	103,859	Suffolk	77,582
Cattaraugus	65,643	Hamilton	4,947	Orleans	30,164	Sullivan	32,306
Cayuga	66,234	Herkimer	51,049	Oswego	70,881	Tioga	27,951
Chautauqua	88,314	Jefferson	76,748	Otsego	48,939	Tompkins	33,830
Chemung	54,063	Kings	1,166,582	Putnam	13,787	Ulster	88,422
Chenango	36,568	Lewis	27,427	Queens	152,999	Warren	29,943
Clinton	47,430	Livingston	37,059	Rensselaer	121,697	Washington	45,624
Columbia	43,211	Madison	40,545	Richmond	67,021	Wayne	48,660
Cortland	27,576	Monroe	217,854	Rockland	38,298	Westchester	183,375
Delaware	46,413	Montgomery	47,488	St. Lawrence	89,083	Wyoming	30,413
Dutchess	81,670	Nassau	55,448	Saratoga	61,089	Yates	20,318
Erie	433,686	New York	2,050,600	Schenectady	46,852		
Essex	30,707	Niagara	74,961	Schoharie	26,854		
Franklin	42,853	Oneida	132,800	Schuyler	15,811		

Total 7,268,012

NORTH CAROLINA.

AREA, 50,704 SQUARE MILES.

Alamance	25,665	Burke	17,699	Clay	4,532	Durham	26,233
Alexander	10,960	Cabarrus	22,456	Cleveland	25,078	Edgecombe	26,591
Alleghany	7,759	Caldwell	15,694	Columbus	21,274	Forsyth	35,261
Anson	21,870	Camden	5,474	Craven	24,160	Franklin	25,116
Ashe	19,581	Carteret	11,811	Cumberland	29,249	Gaston	27,903
Beaufort	26,404	Caswell	15,028	Currituck	6,529	Gates	10,413
Bertie	20,538	Catawba	22,133	Dare	4,757	Graham	4,343
Bladen	17,677	Chatham	23,912	Davidson	23,403	Granville	23,263
Brunswick	12,657	Cherokee	11,860	Davie	12,115	Greene	12,038
Buncombe	44,288	Chowan	10,258	Dulpin	22,405	Guilford	39,074



RIVERS OF THE WORLD.

NORTH CAROLINA—*Continued.*

Halifax	30,793	Madison	20,644	Perquimans	10,091	Swain	8,401
Harnett	15,988	Martin	15,383	Person	16,685	Transylvania	6,620
Haywood	16,222	Mecklenburg	55,268	Pitt	30,889	Tyrrell	4,980
Henderson	14,104	Mitchell	15,221	Polk	7,004	Union	27,156
Hertford	14,294	Montgomery	14,197	Randolph	28,232	Vance	16,684
Hyde	9,278	Moore	23,622	Richmond	28,408	Wake	54,626
Iredell	29,064	Nash	25,478	Robeson	40,371	Warren	19,151
Jackson	11,853	New Hanover	25,785	Rockingham	33,163	Washington	10,608
Johnston	32,250	Northampton	21,150	Rowan	31,066	Watauga	13,417
Jones	8,226	Onslow	11,940	Rutherford	25,101	Wayne	31,356
Lenoir	18,639	Orange	14,690	Sampson	26,380	Wilkes	26,872
Lincoln	15,498	Pamlico	8,045	Stanly	15,220	Wilson	23,596
McDowell	12,567	Pasquotank	13,660	Stokes	19,866	Yadkin	14,083
Macon	12,104	Pender	13,381	Surry	25,515	Yancey	11,464

Total. 1,893,810

NORTH DAKOTA.

AREA, 72,000 SQUARE MILES.

Barnes	13,159	Grand Forks	24,459	Oliver	990	Towner	6,491
Benson	8,320	Griggs	4,744	Pembina	17,869	Traill	13,107
Billings	975	Kidder	1,754	Pierce	4,765	Walsh	20,288
Bottineau	7,532	Lamoure	6,048	Ramsey	9,198	Ward	7,961
Burleigh	6,081	Logan	1,625	Ransom	6,919	Wells	8,310
Cass	28,625	McHenry	5,253	Richland	17,387	Williams	1,530
Cavalier	12,580	McIntosh	4,818	Rolette	7,995	Standing Rock Indian Reservation	2,208
Dickey	6,061	McLean	4,791	Sargent	6,039		
Eddy	3,330	Mercer	1,778	Stark	7,621		
Emmons	4,349	Morton	8,069	Steele	5,888		
Foster	3,770	Nelson	7,316	Stutsman	9,143		

Total 319,146

OHIO.

AREA, 39,964 SQUARE MILES.

Adams	26,328	Fairfield	34,259	Licking	47,070	Portage	29,246
Allen	47,976	Fayette	21,725	Logan	30,420	Preble	23,713
Ashland	21,184	Franklin	164,460	Lorain	54,857	Putnam	32,525
Ashtabula	51,448	Fulton	22,801	Lucas	153,559	Richland	44,289
Athens	38,730	Gallia	27,918	Madison	20,590	Ross	40,940
Auglaize	31,192	Geauga	14,744	Mahoning	70,134	Sandusky	34,311
Belmont	60,875	Greene	31,613	Marion	28,678	Scioto	40,981
Brown	28,237	Guernsey	34,425	Medina	21,958	Seneca	41,163
Butler	56,870	Hamilton	409,479	Meigs	28,620	Shelby	24,625
Carroll	16,811	Hancock	41,993	Mercer	28,021	Stark	94,747
Champaign	26,642	Hardin	31,187	Miami	43,105	Summit	71,715
Clark	58,939	Harrison	20,486	Monroe	27,031	Trumbull	46,591
Clermont	31,610	Henry	27,282	Montgomery	130,146	Tuscarawas	53,751
Clinton	24,202	Highland	30,982	Morgan	17,905	Union	22,342
Columbiana	68,590	Hocking	24,398	Morrow	17,879	Van Wert	30,394
Coshocton	29,337	Holmes	19,511	Muskingum	53,185	Vinton	15,330
Crawford	33,915	Huron	32,330	Noble	19,466	Warren	25,584
Cuyahoga	439,120	Jackson	34,248	Ottawa	22,213	Washington	48,245
Darke	42,532	Jefferson	44,357	Paulding	27,528	Wayne	87,870
Defiance	26,387	Knox	27,768	Perry	31,841	Williams	24,953
Delaware	26,401	Lake	21,680	Pickaway	27,016	Wood	51,555
Erie	37,650	Lawrence	39,534	Pike	18,172	Wyandot	21,125

Total. 4,157,545

OKLAHOMA.

AREA, 2,950 SQUARE MILES.

Beaver	3,051	Garfield	22,076	Noble	14,015	Woods	34,975
Blaine	10,658	Grant	17,273	Oklahoma	25,854	Woodward	7,469
Canadian	15,981	Greer	17,922	Pawnee	12,366	Indian Reservation	12,873
Cleveland	16,388	Kay	22,530	Payne	20,909		
Custer	12,264	Kingfisher	18,501	Pottawatomie	26,412		
Day	2,173	Lincoln	27,007	Roger Mills	6,190		
Dewey	8,819	Logan	26,538	Washita	15,001		

Total 389,245

OREGON.

AREA, 102,606 SQUARE MILES.

Baker	15,597	Gilliam	3,201	Linn	18,603	Union	16,070
Benton	6,706	Grant	5,948	Malheur	4,203	Wallowa	5,538
Clackamas	19,658	Harney	2,598	Marion	27,713	Wasco	13,199
Clatsop	12,765	Jackson	13,698	Morrow	4,151	Washington	14,467
Columbia	6,237	Josephine	7,517	Multomah	103,167	Wheeler	2,443
Coos	10,324	Klamath	3,970	Polk	9,923	Yamhill	13,420
Crook	3,964	Lake	2,847	Sherman	3,477		
Curry	1,868	Lane	19,604	Tillamook	4,471		
Douglas	14,565	Lincoln	3,575	Umatilla	18,049		
Total							413,536

PENNSYLVANIA.

AREA, 46,000 SQUARE MILES.

Adams	34,496	Clinton	29,197	Lackawanna	193,831	Philadelphia	1,293,697
Allegheny	775,058	Columbia	39,896	Lancaster	159 241	Pike	8,766
Armstrong	52,551	Crawford	63,343	Lawrence	57,042	Potter	30,621
Beaver	56,432	Cumberland	50,344	Lebanon	53,827	Schuylkill	172,927
Bedford	39,468	Dauphin	114,443	Lehigh	93,893	Snyder	17,304
Berks	159,615	Delaware	94,762	Luzerne	257,121	Somerset	49,461
Blair	85,099	Elk	32,903	Lycoming	75,663	Sullivan	12,134
Bradford	59,403	Erie	98,473	McKean	51,343	Susquehanna	40,043
Bucks	71,190	Fayette	110,412	Mercer	57,387	Tioga	49,086
Butler	56,962	Forest	11,039	Mifflin	23,160	Union	17,592
Cambria	104,837	Franklin	54,902	Monroe	21,161	Venango	49,648
Cameron	7,048	Fulton	9,924	Montgomery	138,995	Warren	38,946
Carbon	44,510	Greene	28,281	Montour	15,526	Washington	92,181
Center	42,894	Huntingdon	34,650	Northampton	99,687	Wayne	30,171
Chester	95,695	Indiana	42,556	Northumber-		Westmoreland	160,175
Clarion	34,283	Jefferson	59,113	land	90,911	Wyoming	17,152
Clearfield	80,614	Juniata	16,054	Perry	26,263	York	116,413
Total							6,302,115

RHODE ISLAND.

AREA, 1,306 SQUARE MILES.

Bristol	13,144	Newport	32,599	Providence	328,683	Washington	24,154
Kent	29,976						
Total							428,556

SOUTH CAROLINA.

AREA, 29,385 SQUARE MILES.

Abbeville	33,400	Chesterfield	20,401	Greenwood	28,343	Oconee	23,634
Aiken	39,032	Clarendon	28,184	Hampton	23,738	Orangeburg	59,663
Anderson	55,728	Colleton	33,452	Horry	23,364	Pickens	19,375
Bamberg	17,296	Darlington	32,388	Kershaw	24,696	Richland	45,589
Barnwell	35,504	Dorchester	16,294	Lancaster	24,311	Saluda	18,966
Beaufort	35,495	Edgefield	25,478	Laurens	37,382	Spartanburg	65,560
Berkeley	30,454	Fairfield	29,425	Lexington	27,264	Sumter	51,237
Charleston	88,006	Florence	28,474	Marion	35,181	Union	25,501
Cherokee	21,359	Georgetown	22,846	Marlboro	27,639	Williamsburg	31,685
Chester	28,616	Greenville	53,490	Newberry	30,182	York	41,684
Total							1,340,316

SOUTH DAKOTA.

AREA, 78,932 SQUARE MILES.

Aurora	4,011	Davison	7,483	Hyde	1,492	Pennington	5,610
Beadle	8,081	Day	12,254	Jerauld	2,798	Potter	2,988
Bonhomme	10,379	Deuel	6,656	Kingsbury	9,866	Roberts	12,216
Brookings	12,561	Douglas	5,012	Lake	9,137	Sanborn	4,644
Brown	15,286	Edmunds	4,916	Lawrence	17,897	Spink	9,487
Brule	5,401	Fall River	3,541	Lincoln	12,161	Stanley	1,349
Buffalo	1,790	Faulk	3,547	Lyman	2,632	Sully	1,715
Butte	2,907	Grant	9,103	McCook	8,689	Turner	13,175
Campbell	4,527	Gregory	2,211	McPherson	6,327	Union	11,153
Charles Mix	8,498	Hamlin	5,945	Marshall	5,942	Walworth	3,839
Clark	6,942	Hand	4,525	Meade	4,907	Yankton	12,649
Clay	9,316	Hanson	4,947	Miner	5,864	Indian Reser-	
Coddington	8,770	Hughes	3,684	Minnehaha	23,926	vation	16,043
Custer	2,728	Hutchinson	11,897	Moody	8,326		
Total							401,570

TENNESSEE.

AREA, 45,500 SQUARE MILES.

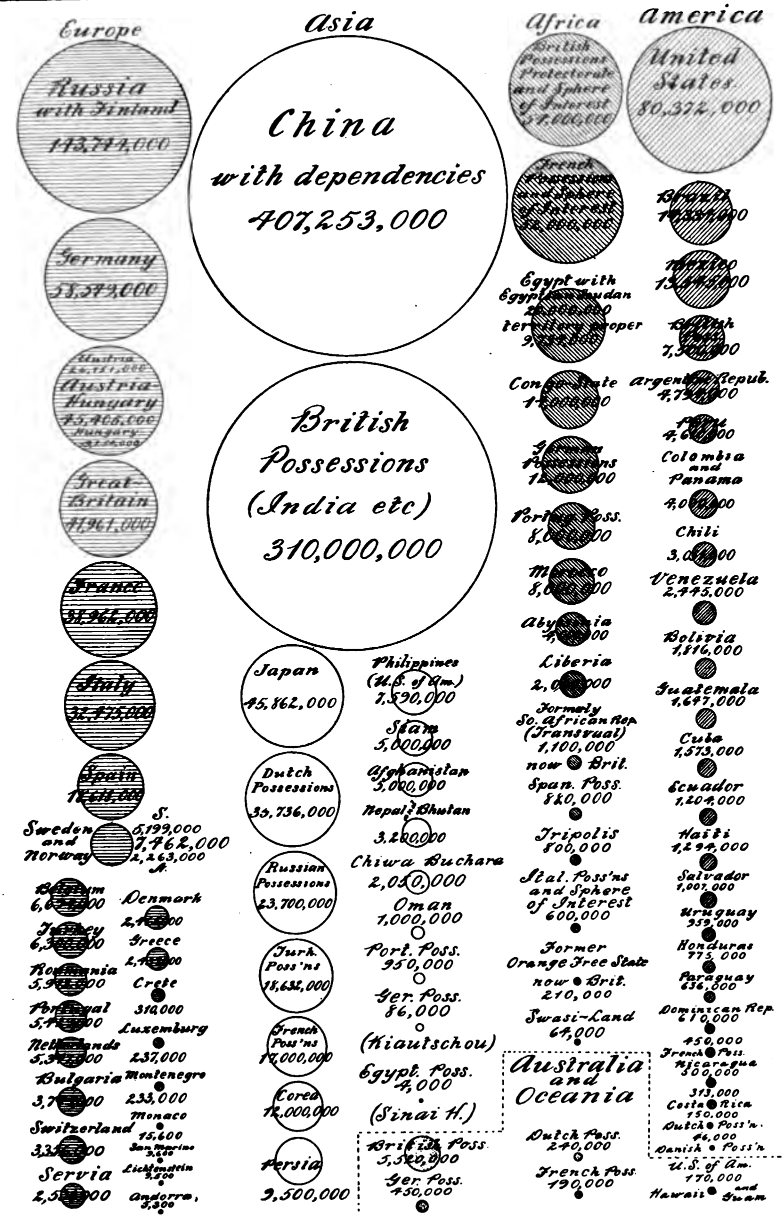
Anderson	17,634	Fentress	6,106	Lake	7,368	Rhea	14,318
Bedford	23,845	Franklin	20,392	Lauderdale	21,971	Roane	22,738
Benton	11,888	Gibson	39,408	Lawrence	15,402	Robertson	25,029
Bledsoe	6,626	Giles	33,035	Lewis	4,455	Rutherford	33,543
Blount	19,206	Grainger	15,512	Lincoln	26,304	Scott	11,077
Bradley	15,759	Greene	30,596	Loudon	10,838	Sequatchie	3,326
Campbell	17,317	Grundy	7,802	McMinn	19,163	Sevier	22,021
Cannon	12,121	Hamblen	12,728	McNairy	17,760	Shelby	153,557
Carroll	24,250	Hamilton	61,695	Macon	12,881	Smith	19,026
Carter	16,688	Hancock	11,147	Madison	36,333	Stewart	15,224
Cheatham	10,112	Hardeman	22,976	Marion	17,281	Sullivan	24,935
Chester	9,896	Hardin	19,246	Marshall	18,763	Sumner	26,072
Claiborne	20,696	Hawkins	24,267	Maury	42,703	Tipton	29,273
Clay	8,421	Haywood	25,189	Meigs	7,491	Trousdale	6,004
Cocke	19,153	Henderson	18,117	Monroe	18,585	Unicoi	5,851
Coffee	15,574	Henry	24,208	Montgomery	36,017	Union	12,894
Crockett	15,867	Hickman	16,367	Moore	5,706	Van Buren	3,126
Cumberland	8,311	Houston	6,476	Morgan	9,587	Warren	16,410
Davidson	122,815	Humphreys	13,398	Obion	28,286	Washington	22,604
Decatur	10,439	Jackson	15,039	Overton	13,353	Wayne	12,936
Dekalb	16,460	James	5,407	Perry	8,800	Weakley	32,546
Dickson	18,635	Jefferson	18,590	Pickett	5,366	White	14,157
Dyer	23,776	Johnson	10,589	Polk	11,357	Williamson	26,429
Fayette	29,701	Knox	74,302	Putnam	16,890	Wilson	27,078

Total. 2,020,616

TEXAS.

AREA, 237,504 SQUARE MILES.

Anderson	28,015	Collingsworth	1,233	Glasscock	286	Kerr	4,980
Andrews	87	Colorado	22,203	Goliad	8,310	Kimble	2,503
Angelina	13,481	Comal	7,008	Gonzales	28,882	King	490
Aransas	1,716	Comanche	23,009	Gray	480	Kinney	2,447
Archer	2,508	Concho	1,427	Grayson	63,661	Knox	2,322
Armstrong	1,205	Cooke	27,494	Gregg	12,343	Lamar	48,627
Atascosa	7,143	Coryell	21,308	Grimes	26,106	Lamb	31
Austin	20,676	Cottle	1,002	Guadalupe	21,385	Lampasas	8,625
Bailey	4	Crane	51	Hale	1,680	Lasalle	2,303
Bandera	5,332	Crockett	1,591	Hall	1,670	Lavaca	28,121
Bastrop	26,845	Crosby	788	Hamilton	13,520	Lee	14,595
Baylor	3,052	Dallam	146	Hansford	167	Leon	18,072
Bee	7,720	Dallas	82,726	Hardeman	3,634	Liberty	8,102
Bell	45,535	Dawson	37	Hardin	5,049	Limestone	32,573
Bexar	69,422	Deaf Smith	843	Harris	63,786	Lipscomb	790
Blanco	4,703	Delta	15,249	Harrison	31,878	Live Oak	2 268
Borden	776	Denton	28,318	Hartley	377	Llano	7,301
Bosque	17,390	Dewitt	21,311	Haskell	2,637	Loving	33
Bowie	26,676	Dickens	1,151	Hays	14,142	Lubbock	293
Brazoria	14,861	Dimmit	1,106	Hemphill	815	Lynn	17
Brazos	18,859	Donley	2,756	Henderson	19,970	McCulloch	3,960
Brewster	2,356	Duval	8,483	Hidalgo	6,837	McLennan	59,772
Briscoe	1,253	Eastland	18,971	Hill	41,355	McMullen	1,024
Brown	16,019	Ector	381	Hockley	44	Madison	10,432
Burleson	18,367	Edwards	3,108	Hood	9,146	Marion	10,754
Burnet	10,528	Ellis	50,059	Hopkins	27,950	Martin	332
Caldwell	21,765	El Paso	24,886	Houston	25,452	Mason	5,573
Calhoun	2,395	Erath	29,966	Howard	2,528	Matagorda	6,097
Callahan	8,768	Falls	33,342	Hunt	47,295	Maverick	4,066
Cameron	16,095	Fannin	51,793	Hutchinson	303	Medina	7,783
Camp	9,146	Fayette	36,542	Iron	848	Menard	2,011
Carson	469	Fisher	3,708	Jack	10,224	Midland	1,741
Cass	22,841	Floyd	2,020	Jackson	6,094	Milam	39,666
Castro	400	Foard	1,568	Jasper	7,138	Mills	7,851
Chambers	3,046	Fort Bend	16,538	Jeff Davis	1,150	Mitchell	2,855
Cherokee	25,154	Franklin	8,674	Jefferson	14,239	Montague	24,800
Childress	2,138	Freestone	18,910	Johnson	33,819	Montgomery	17,067
Clay	9,231	Frio	4,200	Jones	7,053	Moore	209
Cochran	25	Gaines	55	Karnes	8,681	Morris	8,220
Coke	3,430	Galveston	44,116	Kaufman	33,376	Motley	1,257
Coleman	10,077	Garza	185	Kendall	4,103	Nacogdoches	24.663
Collin	50,087	Gillespie	8,229	Kent	899	Navarro	43,374



POPULATION OF THE WORLD.

TEXAS—*Continued.*

Newton......	7,282	Roberts......	620	Sterling......	1,127	Walker.......	15,813
Nolan........	2,611	Robertson....	31,480	Stonewall.....	2,183	Waller.......	14,246
Nueces.......	10,439	Rockwall.....	8,531	Sutton.......	1,727	Ward........	1,451
Ochiltree.....	267	Runnels......	5,379	Swisher......	1,227	Washington...	32,931
Oldham......	349	Rusk........	26,099	Tarrant......	52,376	Webb........	21,851
Orange.......	5,905	Sabine.......	6,394	Taylor.......	10,499	Wharton.....	16,942
Palo Pinto....	12,291	San Augustine.	8,434	Terry........	48	Wheeler......	636
Panola.......	21,404	San Jacinto...	10,277	Throckmorton	1,750	Wichita......	5,806
Parker.......	25,823	San Patricio..	2,372	Titus........	12,292	Wilbarger....	5,759
Parmer.......	34	San Saba.....	7,569	Tom Green...	6,804	Williamson...	38,072
Pecos........	2,360	Schleicher....	515	Travis.......	47,386	Wilson.......	13,961
Polk.........	14,447	Scurry.......	4,151	Trinity.......	10,976	Winkler......	60
Potter.......	1,820	Shackelford...	2,468	Tyler........	11,899	Wise.........	27,116
Presidio......	3,673	Shelby.......	20,452	Upshur.......	16,266	Wood........	21,048
Rains........	6,127	Sherman.....	104	Upton.......	48	Yoakum......	26
Randall......	963	Smith.......	37,370	Uvalde.......	4,647	Young.......	6,540
Red River....	29,893	Somervell....	3,498	Valverde.....	5,263	Zapata.......	4,760
Reeves......	1,847	Starr........	11,469	Van Zandt....	25,481	Zavalla.......	792
Refugio......	1,641	Stephens.....	6,466	Victoria......	13,678		

Total...3,048,710

UTAH.

AREA, 84,476 SQUARE MILES.

Beaver.......	3,613	Grand........	1,149	Rich.........	1,946	Uinta........	6,458
Boxelder.....	10,009	Iron.........	3,546	Salt Lake.....	77,725	Utah.........	32,456
Cache........	18,139	Juab.........	10,082	San Juan.....	1,023	Wasatch.....	4,736
Carbon.......	5,004	Kane........	1,811	Sanpete......	16,313	Washington...	4,612
Davis........	7,996	Millard.......	5,678	Sevier........	8,451	Wayne.......	1,907
Emery.......	4,657	Morgan......	2,045	Summit......	9,439	Weber.......	25,239
Garfield......	3,400	Piute........	1,954	Tooele.......	7,361		

Total 276,749

VERMONT.

AREA, 10,212 SQUARE MILES.

Addison......	21,912	Essex........	8,056	Orange.......	19,313	Windham....	26,660
Bennington...	21,705	Franklin.....	30,198	Orleans......	22,024	Windsor......	32,225
Caledonia.....	24,381	Grand Isle....	4,462	Rutland......	44,209		
Chittenden...	39,600	Lamoille.....	12,289	Washington...	36,607		

Total 343,641

VIRGINIA.

AREA, 38,352 SQUARE MILES.

Accomac.....	32,570	Dickenson....	7,747	King William	8,380	Princess Anne.	11,192
Albemarle....	34,920	Dinwiddie....	15,374	Lancaster....	8,949	Prince William	11,112
Alexandria...	20,959	Elizabeth City.	19,460	Lee..........	19,856	Pulaski.......	14,609
Alleghany....	16,330	Essex........	9,701	Loudoun.....	21,948	Rappahannock	8,843
Amelia.......	9,037	Fairfax.......	18,580	Louisa.......	16,517	Richmond.....	7,088
Amherst......	17,864	Fauquier.....	23,374	Lunenburg...	11,705	Roanoke.....	37,332
Appomattox..	9,662	Floyd........	15,388	Madison.....	10,216	Rockbridge...	24,187
Augusta......	39,659	Fluvanna.....	9,050	Mathews.....	8,239	Rockingham..	33,527
Bath.........	5,595	Franklin.....	25,953	Mecklenburg..	26,551	Russell.......	18,031
Bedford......	30,356	Frederick.....	18,400	Middlesex....	8,220	Scott........	22,694
Bland........	5,497	Giles.........	10,793	Montgomery..	19,196	Shenandoah...	20,253
Botetourt....	17,161	Gloucester....	12,832	Nansemond...	23,078	Smyth.......	17,121
Brunswick....	18,217	Goochland....	9,519	Nelson.......	16,075	Southampton.	22,848
Buchanan....	9,692	Grayson......	16,853	New Kent....	4,865	Spottsylvania.	14,307
Buckingham..	15,266	Greene.......	6,214	Norfolk......	114,831	Stafford......	8,097
Campbell.....	42,147	Greenesville...	9,758	Northampton.	13,770	Surry........	8,469
Caroline......	16,709	Halifax......	37,197	Northumberland	9,846	Sussex.......	12,082
Carroll.......	19,303	Hanover.....	17,618	Nottoway....	12,366	Tazewell.....	23,384
Charles City..	5,040	Henrico......	115,112	Orange.......	12,571	Warren......	8,837
Charlotte.....	15,343	Henry.......	19,265	Page........	13,794	Warwick.....	15,524
Chesterfield...	28,519	Highland.....	5,647	Patrick......	15,403	Washington...	33,574
Clarke.......	7,927	Isle of Wight..	13,102	Pittsylvania..	63,414	Westmoreland	9,243
Craig........	4,293	James City...	5,732	Powhatan....	6,824	Wise........	19,653
Culpeper.....	14,123	King and Queen	9,265	Prince Edward	15,045	Wythe.......	20,437
Cumberland..	8,996	King George..	6,918	Prince George.	7,752	York........	7,482

Total...1,854,184

WASHINGTON.

AREA, 69,994 SQUARE MILES.

Adams	4,840	Ferry	4,562	Lewis	15,157	Snohomish	23,950
Asotin	3,366	Franklin	486	Lincoln	11,969	Spokane	57,542
Chehalis	15,124	Garfield	3,918	Mason	3,810	Stevens	10,543
Chelan	3,931	Island	1,870	Okanogan	4,689	Thurston	9,927
Clallam	5,603	Jefferson	5,712	Pacific	5,983	Wahkiakum	2,819
Clarke	13,419	King	110,053	Pierce	55,515	Wallawalla	18,680
Columbia	7,128	Kitsap	6,767	San Juan	2,928	Whatcom	24,116
Cowlitz	7,877	Kittitas	9,704	Skagit	14,272	Whitman	25,360
Douglas	4,926	Klickitat	6,407	Skamania	1,688	Yakima	13,462
Total							518,103

WEST VIRGINIA.

AREA, 23,000 SQUARE MILES.

Barbour	14,198	Hancock	6,693	Mineral	12,883	Ritchie	18,901
Berkeley	19,469	Hardy	8,449	Mingo	11,359	Roane	19,852
Boone	8,194	Harrison	27,690	Monongalia	19,049	Summers	16,265
Braxton	18,904	Jackson	22,987	Monroe	13,130	Taylor	14,978
Brooke	7,219	Jefferson	15,935	Morgan	7,294	Tucker	13,433
Cabell	29,252	Kanawha	54,696	Nicholas	11,403	Tyler	18,252
Calhoun	10,266	Lewis	16,980	Ohio	48,024	Upshur	14,696
Clay	8,248	Lincoln	15,434	Pendleton	9,167	Wayne	23,619
Doddridge	13,689	Logan	6,955	Pleasants	9,345	Webster	8,862
Fayette	31,987	McDowell	18,747	Pocahontas	8,572	Wetzel	22,880
Gilmer	11,762	Marion	32,430	Preston	22,727	Wirt	10,284
Grant	7,275	Marshall	26,444	Putnam	17,330	Wood	34,452
Greenbrier	20,683	Mason	24,142	Raleigh	12,436	Wyoming	8,380
Hampshire	11,806	Mercer	23,023	Randolph	17,670		
Total							958,800

WISCONSIN.

AREA, 53,924 SQUARE MILES.

Adams	9,141	Florence	3,197	Marathon	43,256	Sauk	33,006
Ashland	20,176	Fond du Lac	47,589	Marinette	30,822	Sawyer	3,593
Barron	23,677	Forest	1,396	Marquette	10,509	Shawano	27,475
Bayfield	14,392	Grant	38,881	Milwaukee	330,017	Sheboygan	50,345
Brown	46,359	Green	22,719	Monroe	28,103	Taylor	11,262
Buffalo	16,765	Green Lake	15,797	Oconto	20,874	Trempealeau	23,114
Burnett	7,478	Iowa	23,114	Oneida	8,875	Vernon	28,351
Calumet	17,078	Iron	6,616	Outagamie	46,247	Vilas	4,929
Chippewa	33,037	Jackson	17,466	Ozaukee	16,363	Walworth	29,259
Clark	25,848	Jefferson	34,789	Pepin	7,905	Washburn	5,521
Columbia	31,121	Juneau	20,629	Pierce	23,943	Washington	23,589
Crawford	17,286	Kenosha	21,707	Polk	17,801	Waukesha	35,229
Dane	69,435	Kewaunee	17,212	Portage	29,483	Waupaca	31,615
Dodge	46,631	La Crosse	42,997	Price	9,106	Waushara	15,972
Door	17,583	Lafayette	20,959	Racine	45,644	Winnebago	58,225
Douglas	36,335	Langlade	12,553	Richland	19,483	Wood	25,865
Dunn	25,043	Lincoln	16,269	Rock	51,203		
Eau Claire	31,692	Manitowoc	42,261	St. Croix	26,830		
Total							2,069,042

WYOMING.

AREA, 97,883 SQUARE MILES.

Albany	13,084	Crook	3,137	Natrona	1,785	Weston	3,203
Bighorn	4,328	Fremont	5,357	Sheridan	5,122	Yellowstone Park	369
Carbon	9,589	Johnson	2,361	Sweetwater	8,455		
Converse	3,337	Laramie	20,181	Uinta	12,223		
Total							92,531

HOW THE POPULATION OF THE UNITED STATES ARE SHELTERED.

In the Census year 1900 there were 14,430,145 dwellings, accommodating 16,187,715 families. Of this number 611,435 dwellings accommodated one person each, 10,158,932 sheltered two to six persons, 2,999,687 accommodated seven to ten persons each, and 660,091 eleven persons and over.

AREA AND POPULATION OF STATE: 1900.

State or Territory	Land surface in square miles, 1900.	Rank in population, 1900.	Population 1900.
United States..	3,567,563	.....	76,303,387
Continental U. S.	2,970,230	.....	75,994,575
N.Atlantic div	162,103	.....	21,046,695
S.Atlantic div.	268,620	.....	10,443,480
N.Central div .	753,550	.....	26,333,004
S.Central div. .	610,215	.....	14,080,047
Western div.. .	1,175,742	.....	4,091,349
Alabama.......	51,540	18	1,828,697
Arizona.......	112,920	49	122,931
Arkansas......	53,045	25	1,311,564
California.....	156,172	21	1,485,053
Colorado......	103,645	31	539,700
Connecticut....	4,845	29	908,420
Delaware......	1,960	46	184,735
District of Columbia......	60	42	278,718
Florida........	54,240	32	528,542
Georgia.......	58,980	11	2,216,331
Idaho.........	84,290	47	161,772
Illinois........	56,000	3	4,821,550
Indiana........	35,910	8	2,516,462
Indian Territory	31,000	39	392,060
Iowa..........	55,475	10	2,231,853
Kansas........	81,700	22	1,470,495
Kentucky......	40,000	12	2,147,174
Louisiana......	45,420	23	1,381,625
Maine.........	29,895	30	694,466
Maryland......	9,860	26	1,188,044
Massachusetts..	8,040	7	2,805,346
Michigan......	57,430	9	2,420,982
Minnesota.....	79,205	19	1,751,394
Mississippi.....	46,340	20	1,551,270
Missouri.......	68,735	5	3,106,665
Montana.......	145,310	44	243,329
Nebraska......	76,840	27	1,066,300
Nevada........	109,740	52	42,335
New Hampshire	9,005	36	411,588
New Jersey....	7,525	16	1,883,669
New Mexico....	122,460	45	195,310
New York.....	47,620	1	7,268,894
North Carolina.	48,580	15	1,893,810
North Dakota..	70,195	41	319,146
Ohio..........	40,760	4	4,157,545
Oklahoma......	38,830	38	398,331
Oregon........	94,560	35	413,536
Pennsylvania...	44,985	2	6,302,115
Rhode Island...	1,053	34	428,556
South Carolina..	30,170	24	1,340,316
South Dakota..	76,850	37	401,570
Tennessee......	41,750	14	2,020,616
Texas.........	262,290	6	3,048,710
Utah.........	82,190	43	276,749
Vermont.......	9,135	40	343,641
Virginia.......	40,125	17	1,854,184
Washington....	66,880	33	518,103
West Virginia..	24,645	28	958,800
Wisconsin......	54,450	13	2,069,042
Wyoming......	97,575	50	92,531
Alaska.......	590,884	51	63,592
Hawaii.......	6,449	48	154,001
Military and naval......	....	.....	91,219

POPULATION LIVING IN CITIES WITHIN SPECIFIED LIMITS OF SIZE AND IN COUNTRY DISTRICTS: 1900.

Divisions.	POPULATION.						
	Total.	In cities of—					In country districts.
		At least 100,000.	25,000 to 100,000.	8,000 to 25,000.	4,000 to 8,000.	2,500 to 4,000.	
United States. .	76,212,168	14,208,347	5,549,271	5,286,375	3,380,193	2,214,136	45,573,348
Continental U. S. . . .	75,994,575	14,208,347	5,509,965	5,273,887	3,380,193	2,211,019	45,411,164
N. Atlantic div.	21,046,695	7,533,280	2,565,416	2,226,013	1,289,027	738,911	6,694,048
S. Atlantic div.	10,443,480	787,675	514,353	475,098	271,894	183,112	8,210,848
N. Central div.	26,333,004	4,714,117	1,383,767	1,957,622	1,287,707	805,714	16,184,077
S. Central div.	14,080,047	594,155	591,870	371,306	339,324	291,598	11,891,794
Western div. . .	4,091,349	579,120	454,059	243,848	192,241	191,684	2,430,397

POPULATION OF CITIES HAVING AT LEAST 25,000 INHABITANTS IN 1900.

Cities.	Rank in population.	Population.	Cities.	Rank in Population.	Population.
Akron, Ohio	87	42,728	Houston, Tex	85	44,633
Albany, N. Y.	40	94,151	Indianapolis, Ind	21	169,164
Allegheny, Pa.	27	129,896	Jackson, Miss.	161	25,180
Allentown, Pa.	114	35,416	Jacksonville, Fla.	143	28,429
Altoona, Pa.	97	38,973	Jersey City, N. J.	17	206,433
Atlanta, Ga.	43	89,872	Johnstown, Pa.	112	35,936
Atlantic City, N. J.	149	27,838	Joliet, Ill.	138	29,353
Auburn, N. Y.	135	30,345	Joplin, Mo.	155	26,023
Augusta, Ga.	94	39,441	Kansas City, Kans.	76	51,418
Baltimore, Md.	6	508,957	Kansas City, Mo.	22	163,752
Bay City, Mich.	151	27,628	Knoxville, Tenn.	126	32,637
Bayonne, N. J.	125	32,722	LaCrosse, Wis.	141	28,895
Binghamton, N. Y.	93	39,647	Lancaster, Pa.	90	41,459
Birmingham, Ala.	100	38,415	Lawrence, Mass.	57	62,559
Boston, Mass.	5	560,892	Lexington, Ky.	153	26,369
Bridgeport, Conn.	54	70,996	Lincoln, Nebr.	91	40,169
Brockton, Mass.	92	40,063	Little Rock, Ark	101	38,307
Buffalo, N. Y.	8	352,387	Los Angeles, Cal.	36	102,479
Butte, Mont.	133	30,470	Louisville, Ky.	18	204,731
Cambridge, Mass.	41	91,886	Lowell, Mass.	39	94,969
Camden, N. J.	52	75,935	Lynn, Mass.	55	68,513
Canton, Ohio.	132	30,667	McKeesport, Pa.	116	34,227
Cedar Rapids, Iowa.	159	25,656	Malden, Mass.	121	33,664
Charleston, S. C.	68	55,807	Manchester, N. H.	65	56,987
Chattanooga, Tenn.	136	30,154	Memphis, Tenn.	37	102,320
Chelsea, Mass.	118	34,072	Milwaukee, Wis.	14	285,315
Chester, Pa.	119	33,988	Minneapolis, Minn.	19	202,718
Chicago, Ill.	2	1,698,575	Mobile, Ala.	99	38,469
Cincinnati, Ohio	10	325,902	Montgomery, Ala.	134	30,346
Cleveland, Ohio.	7	381,768	Nashville, Tenn.	47	80,865
Columbus, Ohio.	28	125,560	Newark, N. J.	16	246,070
Council Bluffs, Iowa.	158	25,802	New Bedford, Mass.	58	62,442
Covington, Ky.	86	42,938	New Britain, Conn.	157	25,998
Dallas, Tex.	88	42,638	Newcastle, Pa.	144	28,339
Davenport, Iowa.	115	35,254	New Haven, Conn.	31	108,027
Dayton, Ohio.	45	85,333	New Orleans, La.	12	287,104
Denver, Colo.	25	133,859	Newport, Ky.	145	28,301
Des Moines, Iowa	59	62,139	Newton, Mass.	123	33,587
Detroit, Mich.	13	285,704	New York, N. Y.*	1	3,437,202
Dubuque, Iowa.	108	36,297	Norfolk, Va.	80	46,624
Duluth, Minn.	72	52,969	Oakland, Cal.	56	66,960
Easton, Pa.	160	25,238	Omaha, Nebr.	35	102,555
East St. Louis, Ill.	137	29,655	Oshkosh, Wis.	146	28,284
Elizabeth, N. J.	74	52,130	Passaic, N. J.	150	27,777
Elmira, N. Y.	113	35,672	Paterson, N. J.	32	105,171
Erie, Pa.	73	52,733	Pawtucket, R. I.	96	39,231
Evansville, Ind	64	59,007	Peoria, Ill.	67	56,100
Fall River, Mass.	33	104,863	Philadelphia, Pa.	3	1,293,697
Fitchburg, Mass.	128	31,531	Pittsburg, Pa.	11	321,616
Fort Wayne, Ind.	83	45,115	Portland, Me.	78	50,145
Fort Worth, Tex.	152	26,688	Portland, Oreg.	42	90,426
Galveston, Tex.	103	37,789	Providence, R. I.	20	175,597
Gloucester, Mass.	154	26,121	Pueblo, Col.	148	28,157
Grand Rapids, Mich.	44	87,565	Quincy, Ill.	109	36,252
Harrisburg, Pa	77	50,167	Racine, Wis.	140	29,102
Hartford, Conn.	49	79,850	Reading, Pa.	50	78,961
Haverhill, Mass.	105	37,175	Richmond, Va.	46	85,050
Hoboken, N. J.	63	59,364	Rochester, N. Y.	24	162,608
Holyoke, Mass.	82	45,712	Rockford, Ill.	130	31,051
Honolulu, Hawaii	95	39,306	Sacramento, Cal.	139	29,282

* The estimated population of the area now embraced in New York city was 2,507,414 in 1890 and 1,911,698 in 1880. Increase 1890 to 1900, 929,788; 1880 to 1890, 595,716. Per cent. of increase 1890 to 1900, 37.1; 1880 to 1890, 31.2.

POPULATION OF CITIES HAVING AT LEAST 25,000 INHABITANTS IN 1900—*Continued.*

Cities.	Rank in Population.	Population.	Cities.	Rank in Population.	Population.
Saginaw, Mich.	89	42,345	Syracuse, N. Y.	30	108,374
St. Joseph, Mo.	34	102,979	Tacoma, Wash.	104	37,714
St. Louis, Mo.	4	575,238	Taunton, Mass.	131	31,036
St. Paul, Minn.	23	163,065	Terre Haute, Ind.	107	36,673
Salem, Mass.	111	35,956	Toledo, Ohio.	26	131,822
Salt Lake City, Utah.	70	53,531	Topeka, Kans.	122	33,608
San Antonio, Tex.	71	53,321	Trenton, N. J.	53	73,307
San Francisco, Cal.	9	342,782	Troy, N. Y.	62	60,651
Savannah, Ga.	69	54,244	Utica, N. Y.	66	56,383
Schenectady, N. Y.	127	31,682	Washington, D. C.	15	278,718
Scranton, Pa.	38	102,026	Waterbury, Conn.	81	45,859
Seattle, Wash.	48	80,671	Wheeling, W. Va.	98	38,878
Sioux City, Iowa.	124	33,111	Wilkesbarre, Pa.	75	51,721
Somerville, Mass.	61	61,643	Williamsport, Pa.	142	28,757
South Bend, Ind.	110	35,999	Wilmington, Del.	51	76,508
South Omaha, Nebr.	156	26,001	Woonsocket, R. I.	147	28,204
Spokane, Wash.	106	36,848	Worcester, Mass.	29	118,421
Springfield, Ill.	117	34,159	Yonkers, N. Y.	79	47,931
Springfield, Mass.	60	62,059	York, Pa.	120	33,708
Springfield, Ohio.	102	38,253	Youngstown, Ohio.	84	44,885
Superior, Wis.	129	31,091			

DEATH RATES FROM CERTAIN CAUSES, FOR THE REGISTRATION AREA, 1900.

Cause.	Death rate per 100,000.	Cause.	Death rate per 100,000.
Pneumonia.	191.9	Diseases of the stomach**	20.0
Consumption*	190.5	Diseases of the brain	18.6
Heart Disease†	134.0	Peritonitis	17.5
Diarrheal diseases‡	85.1	Unknown causes	16.8
Diseases of the kidneys‖	83.7	Measles	13.2
Apoplexy	66.6	Railroad accidents	13.2
Cancer	60.0	Whooping cough	12.7
Old age	54.0	Suicide	11.8
Bronchitis	48.3	Scarlet fever	11.5
Cholera infantum	47.8	Hydrocephalus	11.0
Debility and atrophy	45.5	Drowning	11.0
Inflammation of the brain and meningitis	41.8	Septicemia	10.0
		Appendicitis	9.9
Diphtheria	35.4	Croup	9.8
Typhoid fever	33.8	Diabetes	9.4
Premature birth	33.7	Burns and scalds	8.8
Convulsions	33.1	Malarial fever	8.8
Paralysis§	32.8	Cerebro-spinal fever	7.1
Inanition	27.3	Dropsy	6.9
Influenza	23.9	Rheumatism	6.8
Diseases of the liver¶	22.7	Gunshot wounds	3.8

* Including general tuberculosis.
† Including pericarditis.
‡ Including cholera morbus, colitis, diarrhea, dysentery, and enteritis.
‖ Including Bright's disease.
§ Including general paralysis of the insane.
¶ Including jaundice, and inflammation and abscess of the liver.
** Including gastritis.

FOREIGN BORN POPULATION CLASSIFIED BY PRINCIPAL COUNTRIES OF BIRTH: 1900.

Country of Birth.		Country of Birth.	
Austria	275,907	Italy	484,027
Bohemia	156,891	Mexico	103,393
Canada (English)	784,741	Norway	336,388
Canada (French)	395,066	Poland	383,407
China	81,534	Russia	423,726
Denmark	153,805	Scotland	233,524
England	840,513	Sweden	572,014
France	104,197	Switzerland	115,593
Germany	2,663,418	Wales	93,586
Holland	104,931	Other countries	273,442
Hungary	145,714		
Ireland	1,615,459	Total	10,341,276

POPULATION AT LEAST 10 YEARS OF AGE ENGAGED IN GAINFUL OCCUPATIONS, CLASSIFIED BY SEX AND SPECIFIED OCCUPATIONS: 1900.

Occupation.	Total.	Male.	Female.
All occupations	29,074,117	23,754,205	5,319,912
Agricultural pursuits	10,381,765	9,404,429	977,336
Agricultural laborers	4,410,877	3,747,668	663,209
Dairymen and dairywomen	10,875	9,983	892
Farmers, planters, and overseers	5,674,875	5,347,169	307,706
Gardeners, florists, nurserymen, etc	61,788	58,928	2,860
Lumbermen and raftsmen	72,020	71,920	100
Stock raisers, herders, and drovers	84,988	83,056	1,932
Turpentine farmers and laborers	24,737	24,456	281
Wood choppers	36,075	35,962	113
Other agricultural pursuits	5,530	5,287	243
Professional service	1,258,739	828,163	430,576
Actors, professional showmen, etc	34,760	27,903	6,857
Architects, designers, draftsmen, etc	29,524	28,483	1,041
Artists and teachers of art	24,873	13,852	11,021
Clergymen	111,638	108,265	3,373
Dentists	29,644	28,858	786
Electricians	50,717	50,308	409
Engineers (civil, etc.) and surveyors	43,239	43,155	84
Journalists	30,038	27,845	2,193
Lawyers	114,460	113,450	1,010
Literary and scientific persons	19,066	13,082	5,984
Musicians and teachers of music	92,174	39,815	52,359
Officials (government)*	86,607	78,488	8,119
Physicians and surgeons	132,002	124,615	7,387
Teachers and professors in colleges, etc	446,133	118,519	327,614
Other professional service	13,864	11,525	2,339
Domestic and personal service	5,580,657	3,485,208	2,095,449
Barbers and hairdressers	131,116	125,542	5,574
Bartenders	88,817	88,377	440
Boarding and lodging house keepers	71,281	11,826	59,455
Hotel keepers	54,797	46,264	8,533
Housekeepers and stewards	155,153	8,224	146,929
Janitors and sextons	56,577	48,544	8,033
Laborers (not specified)	2,629,262	2,505,287	123,975
Launderers and laundresses	385,965	50,683	335,282
Nurses and midwives	120,956	12,265	108,691
Restaurant keepers	33,844	28,999	4,845
Saloon keepers	83,746	81,660	2,086
Servants and waiters	1,560,721	276,958	1,283,763
Soldiers, sailors, and marines (United States)	43,235	43,235	....
Watchmen, policemen, firemen, etc	130,590	129,711	879
Other domestic and personal service	34,597	27,633	6,964

* Includes officers of United States Army and Navy.

POPULATION AT LEAST 10 YEARS OF AGE ENGAGED IN GAINFUL OCCUPATIONS, CLASSIFIED BY SEX AND SPECIFIED OCCUPATIONS: 1900—*Continued.*

Occupation.	Total.	Male.	Female.
Trade and transportation	4,766,964	4,263,617	503,347
Agents	241,162	230,606	10,556
Bankers and brokers	73,277	72,984	293
Boatmen and sailors	78,406	78,253	153
Bookkeepers and accountants	254,880	180,727	74,153
Clerks and copyists	630,127	544,881	85,246
Commercial travelers	92,919	91,973	946
Draymen, hackmen, teamsters, etc.	538,933	538,029	904
Foremen and overseers	55,450	54,032	1,418
Hostlers	64,929	64,850	79
Hucksters and peddlers	76,649	73,734	2,915
Livery stable keepers	33,656	33,466	190
Merchants and dealers (except wholesale)	790,886	756,802	34,084
Merchants and dealers (wholesale)	42,293	42,032	261
Messengers and errand and office boys	71,622	64,959	6,663
Officials of banks and companies	74,072	72,801	1,271
Packers and shippers	59,545	39,557	19,988
Porters and helpers (in stores, etc.)	54,191	53,625	566
Salesmen and saleswomen	611,139	461,909	149,230
Steam railroad employees	582,150	580,462	1,688
Stenographers and typewriters	112,364	26,246	86,118
Street railway employees	68,919	68,873	46
Telegraph and telephone linemen	14,757	14,757	....
Telegraph and telephone operators	75,015	52,459	22,556
Undertakers	16,189	15,866	323
Other persons in trade and transportation	53,434	49,734	3,700
Manufacturing and mechanical pursuits	7,085,992	5,772,788	1,313,204
Building trades.			
Carpenters and joiners	600,252	599,707	545
Masons (brick and stone)	160,805	160,638	167
Painters, glaziers, and varnishers	277,541	275,782	1,759
Paper hangers	21,990	21,749	241
Plasterers	35,694	35,649	45
Plumbers and gas and steam fitters	97,785	97,659	126
Roofers and slaters	9,067	9,065	2
Mechanics (not otherwise specified)	9,392	9,351	41
Chemicals and allied products.			
Oil well and oil works employees	24,626	24,573	53
Other chemical workers	14,814	12,035	2,779
Clay, glass, and stone products.			
Brick and tile makers, etc	49,933	49,455	478
Glass workers	49,998	47,377	2,621
Marble and stone cutters	54,460	54,317	143
Potters	16,140	13,200	2,940
Fishing and mining.			
Fishermen and oystermen	68,177	67,715	462
Miners and quarrymen	563,866	562,501	1,365
Food and kindred products.			
Bakers	79,188	74,860	4,328
Butchers	113,956	113,578	378
Butter and cheese makers	19,241	18,593	648
Confectioners	31,194	21,980	9,214
Millers	40,548	40,362	186
Other food preparers	28,782	23,640	5,142
Iron and steel and their products.			
Blacksmiths	226,477	226,284	193
Iron and steel workers	290,611	287,241	3,370
Machinists	283,145	282,574	571
Steam boiler makers	33,046	33,038	8
Stove, furnace, and grate makers	12,473	12,430	43
Tool and cutlery makers	28,122	27,376	746
Wheelwrights	13,505	13,495	10
Wire workers	18,487	16,701	1,786

POPULATION AT LEAST 10 YEARS OF AGE ENGAGED IN GAINFUL OCCUPATIONS, CLASSIFIED BY SEX AND SPECIFIED OCCUPATIONS: 1900—*Continued.*

Occupation.	Total.	Male.	Female.
Manufacturing and mechanical pursuits.—(*Continued*).			
Leather and its finished products.			
Boot and shoe makers and repairers	208,912	169,393	39,519
Harness and saddle makers and repairers	40,101	39,506	595
Leather curriers and tanners	42,671	40,917	1,754
Trunk and leather-case makers, etc	7,051	5,472	1,579
Liquors and beverages.			
Bottlers and soda water makers, etc	10,519	9,725	794
Brewers and maltsters	20,962	20,687	275
Distillers and rectifiers	3,144	3,114	30
Lumber and its remanufactures.			
Cabinetmakers	35,619	35,552	67
Coopers	37,200	37,087	113
Saw and planing mill employees	161,624	161,251	373
Other woodworkers	111,273	104,468	6,805
Metals and metal products other than iron and steel.			
Brass workers	26,760	25,870	890
Clock and watch makers and repairers	24,120	19,305	4,815
Gold and silver workers	26,112	19,732	6,380
Tinplate and tinware makers	70,505	68,730	1,775
Other metal workers	56,602	54,282	2,320
Paper and printing.			
Bookbinders	30,278	14,646	15,632
Box makers (paper)	21,098	3,796	17,302
Engravers	11,151	10,698	453
Paper and pulp mill operatives	36,328	26,904	9,424
Printers, lithographers, and pressmen	155,147	139,166	15,981
Textiles.			
Bleachery and dye works operatives	22,278	20,493	1,785
Carpet factory operatives	19,388	10,371	9,017
Cotton mill operatives	246,004	125,788	120,216
Hosiery and knitting mill operatives	47,120	12,630	34,490
Silk mill operatives	54,460	22,023	32,437
Woolen mill operatives	73,196	42,566	30,630
Other textile mill operatives	104,619	53,437	51,182
Dressmakers	346,884	2,090	344,794
Hat and cap makers	22,733	15,110	7,623
Milliners	87,859	1,739	86,120
Seamstresses	150,942	4,837	146,105
Shirt, collar, and cuff makers	39,432	8,491	30,941
Tailors and tailoresses	229,649	160,714	68,935
Other textile workers	29,967	8,925	21,042
Miscellaneous industries.			
Broom and brush makers	10,220	8,643	1,577
Charcoal, coke, and lime burners	14,448	14,405	43
Engineers and firemen (not locomotive)	223,495	223,318	177
Glove makers	12,271	4,503	7,768
Manufacturers and officials, etc	243,082	239,649	3,433
Model and pattern makers	15,073	14,869	204
Photographers	26,941	23,361	3,580
Rubber factory operatives	21,866	14,492	7,374
Tobacco and cigar factory operatives	131,452	87,955	43,497
Upholsterers	30,821	28,663	2,158
Other miscellaneous industries	471,300	380,490	90,810

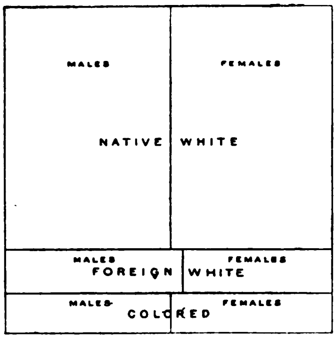
—*From Reports of the Twelfth Census.*

The annals of the Pasteur Institute state that during the year 1902 the number of persons under treatment for hydrophobia in Paris was 1,106, of whom only three died, one cf whom had not completed the treatment when he succumbed to hydrophobia; so that in reality there were only two deaths. Of the 1,106 persons under treatment, nine were English, two Spaniards, two Russians, and one each Greek, Dutch, and Swiss—making 16 foreigners to 1,089 French. The diminution in the number of French patients, as compared with several preceding years, is explained by the opening of anti-rabic institutes at Lille, Marseilles, Montpellier, Lyons, and Bordeaux, to one or other of which persons residing in the neighborhood of those towns have been sent instead of going to Paris.

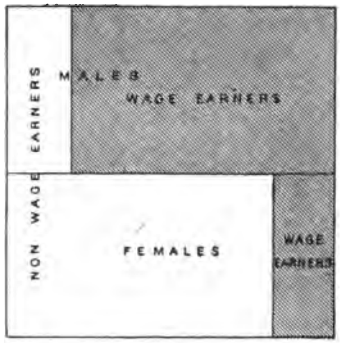
INDIANS.

In 1902 the area of Indian reservations in the United States was 75,148,643 acres or 117,420 square miles, and the population in 1900 was 270,544, but in 1903 the number had dwindled to 263,233. Indian Territory is occupied by 76,886 Indian inhabitants, while 43,746 live in Arizona and 13,799 in Oklahoma, and 19,477 in South Dakota. The census gives the Indian population in Indian Territory in 1900 as 302,060, and the Indian population elsewhere is included in the census of the States.

DIVISION OF POPULATION BY COLOR.



COMPARISON OF POPULATION BY OCCUPATIONS.



NUMBER OF PENSIONERS ON THE ROLLS, FIRST PAYMENTS, AND AMOUNTS OF DISBURSEMENTS FOR PENSIONS FROM 1861 TO 1903.

Year ending June 30—	Number of pensioners on the rolls.			Total disbursements.	Cost, maintenance, and expenses.
	Invalids.	Widows, etc.	Total.		
1861.....	4,337	4,299	8,636	$1,072,461.55	....
1865.....	35,880	50,106	85,986	8,525,153.11	....
1868.....	75,957	93,686	169,643	24,010,981.99	$553,020.34
1870.....	87,521	111,165	198,686	27,780,811.81	600,997.86
1875.....	122,989	111,832	234,821	29,683,116.63	982,695.35
1880.....	145,410	105,392	250,802	57,240,540.14	935,027.28
1890.....	415,654	122,290	537,944	106,493,890.19	3,526,382.13
1900.....	752,510	241,019	993,529	138,462,130.65	3,841,706.74
1903.....	729,356	267,189	996,545	137,759,653.71	3,993,216.79

The following amounts have been paid to soldiers, their widows, minor children, and dependent relatives on account of military and naval service during the wars in which the United States has been engaged:

Revolutionary war (estimated).....................................	$70,000,000.00
War of 1812 (on account of service, without regard to disability)..........	45,186,197.22
Indian wars (on account of service, without regard to disability)..........	6,234,414.55
War with Mexico (on account of service, without regard to disability).....	33,483,309.91
War of the rebellion	2,878,240,400.17
War with Spain..	5,479,268.31
Actual total disbursements in pensions........................	$3,038,623,590.16

—*Statistical Abstract of the United States.*

IMMIGRATION.

NUMBER AND NATIONALITY OF IMMIGRANTS ARRIVED IN THE UNITED STATES DURING THE YEARS ENDING JUNE 30, 1889, 1899, AND 1903.

Countries.	1889.	1899.	1903.
Austria-Hungary:			
Bohemia	3,085	....	....
Hungary	10,967	62,491	206,011
Other Austria (except Poland)	20,122	....	....
Total	34,174	62,491	206,011
Belgium	2,562	1,101	3,450
Denmark	8,699	2,690	7,158
France	5,918	1,694	5,578
Germany	99,538	17,476	40,086
Gibraltar	13	....	....
Greece	158	2,333	14,090
Italy, continental	24,848	77,419	230,622
Sicily and Sardinia	459		
Malta	......	....	....
Netherlands	6,460	1,029	3,998
Norway	13,390	6,705	24,461
Poland	4,922	....	....
Portugal	57	2,054	9,317
Roumania	893	1,606	9,310
Russia (except Poland)	31,889	60,982	136,093
Finland	2,027		
Spain	526	385	2,080
Sweden	35,415	12,797	46,028
Switzerland	7,070	1,326	3,983
Turkey in Europe*	252	132	3,290
United Kingdom:			
England	68,503	10,402	26,219
Ireland	65,557	31,673	35,310
Scotland	18,296	1,724	6,143
Wales	1,181	1,324	1,275
Total United Kingdom	153,537	45,123	68,947

Countries.	1889.	1899.	1903.
Azores	1,967	....	....
Greenland, Iceland and the Faroe Islands	4	....	....
Europe not specified	12	6	5
Total Europe	434,790	297,349	814,507
British North America	..... †	1,322	1,058
Mexico	..... †	161	528
Central America	88	159	678
Bermuda	21	....	....
West Indies and Miquelon	4,923	2,585	8,170
South America	427	89	589
Total America	†5,459	4,316	11,023
China	118	1,660	2,209
Japan	640	2,844	19,968
Other Asia	967	4,468	7,789
Total Asia	1,725	8,972	29,966
Total Oceania	2,196	....	1,349
Total Africa	187	51	176
All other countries	70	1,027	25
Total immigrants	444,427	311,715	857,046

* Includes Servia, Bulgaria, and Montenegro.

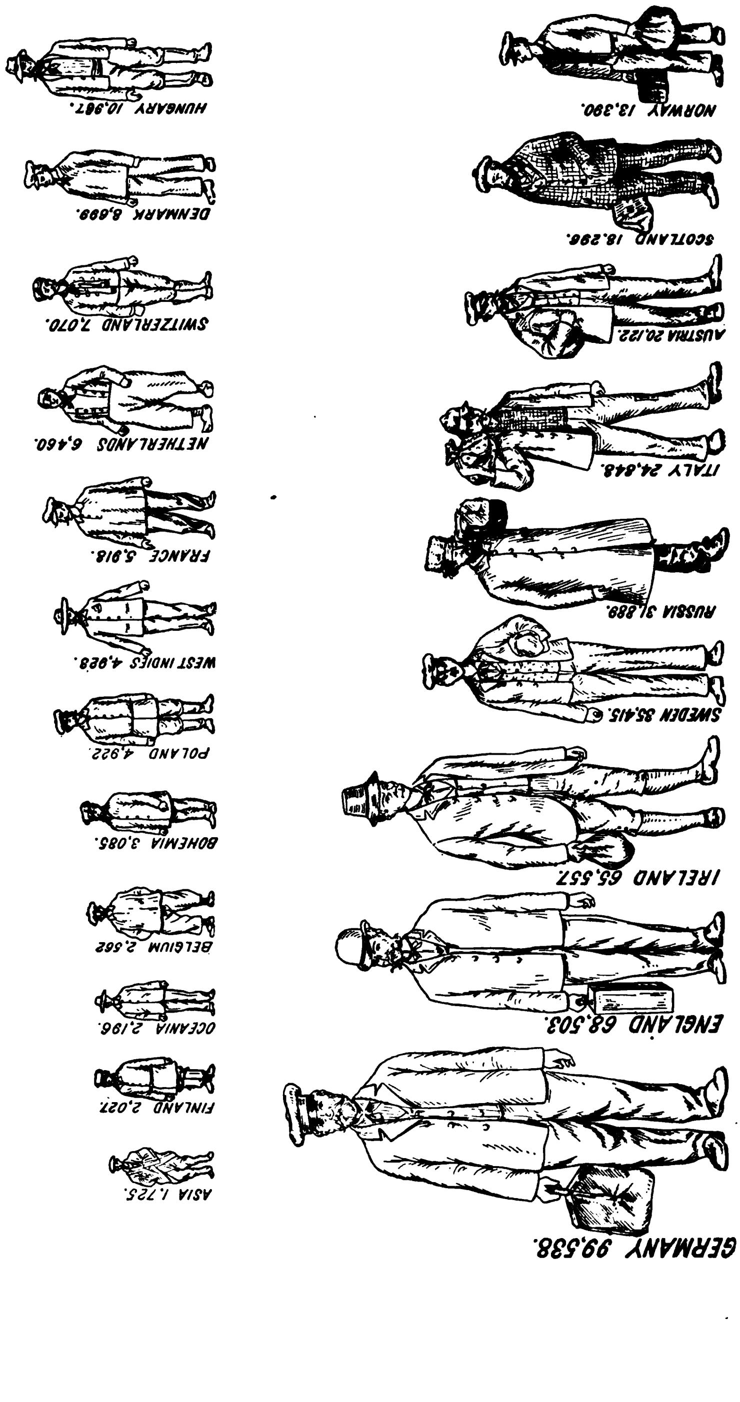
† Immigrants from British North America and Mexico not reported.

—*Statistical Abstract of United States.*

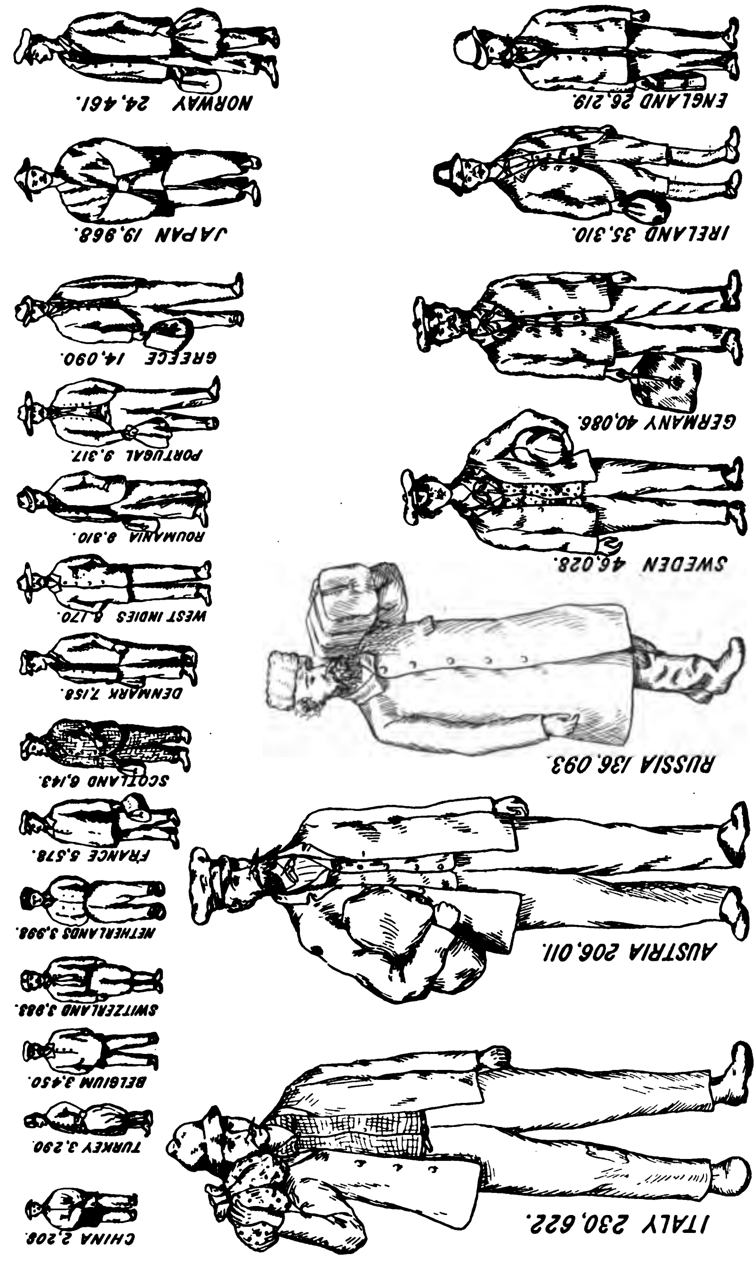
LABOR'S DEATH ROLL.

No less than 4,513 lives were lost in 1902 while in the ordinary pursuit of their calling in the United Kingdom. 112,133 persons were injured in the same period. The percentage of deaths from different causes in coal mining was (1) On the surface, 11.3; (2) Miscellaneous underground, 28.3; (3) In the shafts, 9.9; (4) By falls of ground, 44.1; (5) By explosions, 6.4.	Number Employed According to Latest Returns.	Killed.		Injured.	
		1898.	1902.	1898.	1902.
Factories	3,929,213	575	837	49,290	77,118
Mines	855,603	941	1,053	4,408	3,999
Quarries	97,108	134	119	1,434	1,190
Shipping (Merchant Vessels)	230,161	1,139	1,397	2,354	2,228
Railway service	575,834	522	468	12,826	13,735
Workshops	Cannot be stated.	2	9	135	224
Laundries		......	1	217	355
Docks, wharves, and quays		89	129	4,070	4,906
Warehouses		16	42	2,507	4,235
Buildings		45	89	616	2,412
Railway service (contractors' servants)		20	17	153	123
Under notice of Accidents Act, 1894		56	62	1,491	1,451
Shipping (Fishing vessels, etc.)		271	290	132	157
Total	....	3,810	4,513	79,633	112,133

—*"Daily Mail" Year Book.*



THE TIDE OF IMMIGRATION—STATUS IN 1889.



THE TIDE OF IMMIGRATION—STATUS IN 1903.

ACCESSIONS OF TERRITORY AND TH

★ with date shows center o

CENTER OF POPULATION, 1790-1900.

population at different periods.

TERRITORIAL EXPANSION.

There have been sixteen additions to the original territory of the Union, including Alaska, the Hawaiian, Philippine and Samoan Islands and Guam, in the Pacific, and Porto Rico, in the West Indies; and the Panama strip; and the total area of the United States, including the noncontiguous territory, is now fully five times that of the original thirteen colonies.

The additions to the territory of the United States subsequent to the peace treaty with Great Britain of 1783, are shown by the following table, prepared by the General Land Office of the Interior Department:

ADDITIONS TO THE TERRITORY OF THE UNITED STATES FROM 1800 TO 1904.

Territorial Division.	Year.	Area added.	Purchase price.
		Square miles.	*Dollars.*
Louisiana purchase	1803	875,025	15,000,000
Florida	1819	70,107	*6,489,768
Texas	1845	389,795	....
Oregon Territory	1846	288,689	....
Mexican cession	1848	523,802	†18,250,000
Purchase from Texas	1850	(‡)	10,000,000
Gadsden purchase	1853	36,211	10,000,000
Alaska	1867	599,446	7,200,000
Hawaiian Islands	1897	6,740	....
Porto Rico	1898	3,600	....
Guam	1898	175	....
Philippine Islands	1899	143,000	20,000,000
Samoan Islands	1899	73	....
Additional Philippines	1901	68	100,000
Panama Canal	1903	....	40,000,000
Panama Canal strip	1904	....	10,000,000
Total	....	2,936,731	137,039,768

* Includes interest payment.
† Of which $3,250,000 was in payment of claims of American citizens against Mexico.
‡ Area purchased from Texas amounting to 123,784 square miles is not included in the column of area added, because it became a part of the area of the United States with the admission of Texas.

AREA AND POPULATION OF THE UNITED STATES.

The following table, published by the United States Census Office, shows the gross area and population of the United States at each of the decennial censuses from 1790 to 1900, exclusive of all noncontiguous territory.

Year.	Area.	Population.	Year.	Area.	Population.
	Square miles.			*Square miles.*	
1790	827,844	3,929,214	1850	2,980,959	23,191,876
1800	827,844	5,308,483	1860	3,025,600	31,443,321
1810	1,999,775	7,239,881	1870	3,025,600	38,558,371
1820	2,059,043	9,633,822	1880	3,025,600	50,155,783
1830	2,059,043	12,866,020	1890	3,025,600	62,622,250
1840	2,059,043	17,069,453	1900	3,025,600	75,994,575

CHAPTER VII.

EDUCATION, LIBRARIES, PRINTING AND PUBLISHING.

THE VALUE OF AN EDUCATION.

In the annual report of the United States Commissioner of Education appears a sheet of statistics showing to what extent higher education affects success in life. Particularly it shows the pre-eminence of the A.B. degree man among the successful, and the inconspicuousness of the self-educated.

The standard of success to which the educational statistics are applied is that which constitutes eligibility to the ranks of the 10,000 or so persons included in "Who's Who in America"—that is, according to the editors, "the most notable in all departments of usefulness and reputable endeavor." These men have all reported the scope and method of their education.

The United States Bureau of Education divides the 14,794,403 males over 30 years old in the United States according to the last census into four educational classes, as follows:

Class I. Without education	1,757,023
Class II. With only common school training or trained outside of organized schools	12,054,335
Class III. With regular high school training added	657,432
Class IV. With college or higher education added..	325,613

Omitting those few who are under 30 years old, says this report, the statements from 10,704 notables show that they include: Without education, none; self-taught, 24; home taught, 278; with common school training only, 1,066; with high school training, 1,627; with college training, 7,709, of whom 6,129 were graduates. That is:

From 1800 to 1870 the uneducated boy in the United States failed entirely to become so notable in any department of usefulness and reputable endeavor as to attract the attention of the "Who's Who" editors, and that only 24 self-taught men succeeded.

A boy with only a common school education had, in round numbers, one chance in 9,000.

A high school training increased this chance nearly twenty-two times.

College education added gave the young man about ten times the chance of a high school boy and 200 times the chance of the boy whose training stopped with the common school.

The A.B. graduate was pre-eminently successful, and the self-educated man was inconspicuous.

"From the nature of the case," concludes the compiler, "it cannot be claimed that these classifications are exact, but they are based upon the fullest statistics ever obtained, and the necessary estimates have been made by government experts. It is also doubtless true that other circumstances contributed to the success of these trained men, but after all reasonable allowances are made the figures force the conclusion that the more school training the American boy of that period had, the greater were his chances of distinction.

"It is unnecessary to extend this inquiry to woman," he says, in conclusion. "Education is practically her only door to eminence."

Professor Ramsay, of University College, London, in a letter to the "Times," points out the remarkable part which Technical Education plays in German trade.

"A German company employs no fewer than 70 chemists; it is one which manufactures no product of which it sells less than one hundred tons a year. Of the seventy chemists required, 20 are employed in analyzing the raw materials and intermediate and finished products; 25 are engaged in superintending the processes of manufacture, and the remaining 25 are exclusively employed in scientific work to improve the present processes of manufacture."
—*Daily Mail Year Book.*

NUMBER OF PUPILS AND STUDENTS OF ALL GRADES IN BOTH PUBLIC AND PRIVATE SCHOOLS AND COLLEGES, 1901-2.

NOTE.—The classification of States made use of in the following table is the same as that adopted by the United States census, and is as follows: *North Atlantic Division:* Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania. *South Atlantic Division:* Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, and Florida. *South Central Division:* Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Arkansas, Oklahoma, and Indian Territory. *North Central Division:* Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, and Kansas. *Western Division:* Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California.

Division.	Pupils Receiving Elementary Instruction (Primary and Grammar Grades).		Pupils Receiving Secondary Instruction (High-school Grades).[1]		Students Receiving Higher Instruction.										
					In Universities and Colleges.[3]			In Schools of Medicine, Law, and Theology.[5]			In Normal Schools.[7]			Total Higher.	
	Public.	Private (largely estimated).	Public.[2]	Private (in Preparatory Schools, Academies, Seminaries, etc.).	Public.[4]	Private.	Total.	Public.[6]	Private.	Total.	Public.	Private.	Total.	Public.	Private.
The United States	15,375,276	1,103,901	566,124	168,636	39,487	80,009	119,496	10,726	50,773	61,499	49,403	15,665	[8]65,068	99,616	146,447
N. Atlantic Div. . .	3,552,652	383,870	184,800	53,279	5,470	31,150	36,620	270	17,898	18,168	17,242	1,268	18,510	22,982	50,316
S. Atlantic Div. . .	2,251,329	107,005	30,953	25,589	4,710	11,129	15,839	1,392	6,803	8,195	4,083	1,558	5,641	10,185	19,490
S. Central Div. . . .	3,116,136	159,714	43,060	30,567	3,772	11,263	15,035	1,326	5,918	7,244	5,261	2,277	7,538	10,359	19,458
N. Central Div . .	5,599,946	407,624	269,467	48,719	19,601	23,281	42,882	6,826	18,492	25,318	18,907	10,485	29,392	45,334	52,258
Western Division. .	855,213	45,688	37,844	10,482	5,934	3,186	9,120	912	1,662	2,574	3,910	77	3,987	10,756	4,925

Division.	Summary of Pupils by Grade.			Summary According to Control.		Grand Total.	Per Cent. in Each Grade of the Whole Number of Pupils.			Per Cent. of Public Pupils.			Per Cent. of the Total Population Enrolled in Each Grade.			
	Elementary.	Secondary.	Higher.	Public.	Private.		Elementary.	Secondary	Higher.	Elementary.	Secondary.	Higher.	Elementary	Secondary.	Higher.	Total.
The United States. .	16,479,177	734,760	246,063	16,041,016	1,418,984	17,460,000	94.38	4.21	1.41	93.30	77.05	40.48	20.98	0.94	0.31	22.23
N. Atlantic Division.	3,936,522	238,079	73,298	3,760,434	487,465	4,247,899	92.67	5.60	1.73	90.25	77.62	31.35	18.05	1.09	0.34	19.48
S. Atlantic Division..	2,358,334	56,542	29,675	2,292,467	152,084	2,444,551	96.47	2.31	1.22	95.46	54.74	34.32	22.05	0.53	0.27	22.85
S. Central Division. .	3,275,850	73,627	29,817	3,169,555	209,739	3,379,294	96.94	2.18	0.88	95.12	58.48	34.74	22.26	0.50	0.20	22.96
N. Central Division .	6,007,570	318,186	97,592	5,914,747	508,601	6,423,348	93.53	4.95	1.52	93.21	84.69	46.45	22.33	1.18	0.36	23.87
Western Division. . .	900,901	48,326	15,681	903,813	61,095	964,908	93.37	5.01	1.62	94.93	78.31	68.59	20.39	1.09	0.36	21.84

[1] Including pupils in preparatory or academic departments of higher institutions, public and private, and excluding elementary pupils who are classed in columns 2 and 3.

[2] This is made up from the returns of individual high schools to the Bureau, and is somewhat too small, as there are many secondary pupils outside the completely organized high schools whom there are no means of enumerating.

[3] Including colleges for women, agricultural and mechanical (land-grant) colleges, and scientific schools. Students in law, theological, and medical departments are excluded, being tabulated in columns 9–11. Students in academic and preparatory departments are also excluded, being tabulated in columns 4 and 5.

[4] Mainly State universities and agricultural and mechanical colleges.

[5] Including schools of dentistry, pharmacy, and veterinary medicine.

[6] Mainly in schools or departments of medicine and law attached to State universities.

[7] Non-professional pupils in normal schools are included in columns 4 and 5

[8] There are, in addition to this number, 29,065 students taking normal courses in universities, colleges, and public and private high schools.

POPULATION, ENROLLMENT, AVERAGE DAILY ATTENDANCE, NUMBER, AND SEX OF TEACHERS.

Division.	Estimated Total Population in 1902.	Pupils Enrolled in the Elementary and Secondary Common Schools.	Per Cent. of the Population Enrolled	Average Daily Attendance.	Number of Teachers. Male.	Female.	Total.
The United States....	78,544 816	15,925,887	20.28	10,999,273	122,392	317,204	439,596
North Atlantic Division	21,802,750	3,733,683	17.12	2,741,360	18,069	90,003	108,072
South Atlantic Division..	10,696,435	2,279,290	21.31	1,445,797	19,567	31,818	51,385
South Central Division.	14,715,700	3,156,590	21.45	2,097,819	30,652	34,848	65,500
North Central Division.	26,912,400	5,866,396	21.80	4,101,022	48,152	139,691	187,843
Western Division......	4,417,531	889,928	20.15	613,275	5,952	20,844	26,796

AVERAGE NUMBER OF DAYS TAUGHT, SALARIES OF TEACHERS, VALUE OF SCHOOL PROPERTY, AND STATE AND LOCAL TAXATION, 1901-2.

Division.	Average Number of Days the Schools were Kept.	Average Monthly Salaries of Teachers. Males.	Females.	Value of Public School Property.	Raised from State Taxes.	Raised from Local Taxes.	Raised from Other Sources, State and Local, etc.
The United States. .	145	$49.05	$39.77	$601,571,307	$38,330,589	$170,779.586	$29,742,141
North Atlantic Div.	177.3	59.01	40.17	243,150,033	12,831,775	69,984,121	10,847,513
S. Atlantic Div.....	115.8	30.50	28.60	25,109,903	5,148,670	7,842,256	1,150,494
S. Central Division..	100.6	44.28	36.88	29,875,383	6,398,383	6,869,991	1,147,567
N. Central Division..	156.5	50.85	39.60	250,303,396	8,374,009	74,215,693	14,781,748
Western Division...	143.9	65.90	53.73	53,132,592	5,577,752	11,867,525	1,814,819

STATISTICS OF CITY SCHOOL SYSTEMS, 1901-2.

ENROLLMENT, AVERAGE ATTENDANCE, LENGTH OF SCHOOL TERM, NUMBER OF TEACHERS, AND EXPENDITURES IN CITIES OF 8,000 INHABITANTS AND OVER.

Division.	Number of City School Systems.	Enrollment in Public Day Schools.	Average Daily Attendance.	Average Length of School Term.	Number of Teachers and Supervisors. Male.	Female.	Expenditure for Supervision and Teaching.	Expenditure for all Purposes (Payment of Loans and Bonds Excepted).
United States...	580	4,174,812	3,159,441	187.3	9,461	86,308	$66,561,505	$111,159,665
N. Atlantic Div. .	242	2,046,001	1,537,500	188.4	4,343	42,626	35,543,105	59,950,666
S. Atlantic Div. .	44	292,143	205,948	181.7	809	5,492	3,436,613	5,398,312
S. Central Div. ..	51	223,538	167,816	181.5	628	4,149	2,483,299	3,539,463
N. Central Div. .	205	1,371,398	1,066,804	187.6	3,135	28,909	20,729,416	35,112,492
Western Div. ...	38	241,732	181,373	186.5	546	5,132	4,369,072	7,158,732

STATISTICS OF SECONDARY EDUCATION, 1901-2.

INSTRUCTORS AND STUDENTS IN PUBLIC HIGH SCHOOLS AND IN PRIVATE HIGH SCHOOLS AND ACADEMIES.

Division.	Number.	Public High Schools. Secondary Teachers. Male.	Female.	Secondary Students. Male.	Female.	Number.	Private Secondary Schools. Secondary Teachers. Male.	Female.	Secondary Students. Male.	Female.
United States...	6,292	10,958	11,457	226,914	323,697	1,835	4,073	5,830	51,536	53,154
N. Atlantic Div..	1,476	2,960	4,333	75,888	105,143	650	1,885	2,529	20,900	18,893
S. Atlantic Div..	436	691	568	11,024	16,937	350	629	852	9,098	9,610
S. Central Div...	702	1,037	755	16.450	24,004	364	589	735	9,805	9,541
N. Central Div...	3,333	5,535	5,084	109,736	156,714	343	704	1,295	8,680	11,248
Western Div. ...	345	735	717	13,816	20,899	128	266	419	3,053	3,862

STATISTICS OF HIGHER EDUCATION, 1901-2.

INSTRUCTORS AND STUDENTS IN PUBLIC AND PRIVATE NORMAL SCHOOLS OF THE UNITED STATES.

Division.	Number.	Public Normal Schools. Teachers of Normal Students. Male.	Female.	Students in Normal Course. Male.	Female.	Number.	Private Normal Schools. Teachers of Normal Students. Male.	Female.	Students in Normal Course. Male.	Female.
United States.....	173	1,024	1,463	12,209	37,194	109	445	345	7,484	8,181
N. Atlantic Div.. ..	62	325	661	3,255	13,987	7	60	88	307	961
S. Atlantic Div. ...	25	124	197	1,013	3,070	28	53	79	603	955
S. Central Division	24	132	110	1,868	3,393	27	83	64	1,129	1,148
N. Central Division	40	315	366	5,341	13,566	46	245	107	5,431	5,054
Western Division..	22	128	129	732	3,178	1	4	7	14	63

INSTRUCTORS AND STUDENTS IN COEDUCATIONAL COLLEGES AND UNIVERSITIES AND IN COLLEGES FOR MEN ONLY, 1901-2.

Division.	Number of Institutions.	Professors and Instructors. Male.	Female.	Students. Preparatory. Male.	Female.	Collegiate. Male.	Female.	Resident Graduate. Male.	Female.	Total Income.
United States.	464	9,329	1,907	32,094	14,508	62,430	21,051	3,895	1,456	$25,112,169
N. Atlan. Div.	85	3,000	164	6,408	960	22,903	2,629	1,696	444	9,382,226
S. Atlan. Div.	73	1,050	169	3,465	1,532	6,629	1,081	452	36	2,115,295
S. Central Div	77	878	305	5,761	3,026	6,467	2,472	155	69	2,172,238
N. Central Div	190	3,583	1,085	13,871	7,188	21,993	12,043	1,376	700	8,944,906
Western Div..	39	818	184	2,589	1,802	4,438	2,826	216	207	2,497,504

INSTRUCTORS AND STUDENTS IN SCHOOLS OF TECHNOLOGY AND INSTITUTIONS CONFERRING ONLY THE B. S. DEGREE, 1901-2.

Division.	Number of Institutions.	Professors and Instructors.		Students.						Total Income.
				Preparatory.		Collegiate		Resident Graduate.		
		Male.	Female.	Male.	Female.	Male.	Female.	Male.	Female.	
United States.	43	1,292	132	3,058	673	11,667	1,148	141	54	$4,796,613
N. Atlan. Div.	10	385	13	267	8	3,022	91	22	5	1,645,180
S. Atlan. Div.	8	250	0	291	0	2,255	1	30	0	796,580
S. Cent. Div.	5	112	4	804	129	1,258	57	25	4	425,642
N. Cent. Div.	11	362	74	1 023	230	4,115	683	51	37	1,275,480
Western Div.	9	183	41	673	306	1,017	316	13	8	653,731

INSTRUCTORS AND STUDENTS IN COLLEGES AND SEMINARIES FOR WOMEN WHICH CONFER DEGREES, 1901-2.

Division.	Number of Institutions.	Professors and Instructors.		Female Students.			Total Income.
		Male.	Female.	Preparatory.	Collegiate.	Graduate.	
United States	131	670	1,767	7,610	16.534	326	$3,954,462
North Atlantic Div.	19	295	459	1,281	5,376	157	1,888,799
South Atlantic Div.	45	203	517	2,006	5,236	77	906,852
South Central Div.	46	107	472	2,675	4,377	65	646,048
North Central Div.	19	57	269	1,423	1,493	26	467,763
Western Division	2	8	50	225	52	1	47,000

SUMMARY OF STATISTICS OF PROFESSIONAL SCHOOLS FOR 1901-2.

Division.	Theological.			Law.			Medical.		
	Schools.	Instructors.	Students.	Schools.	Instructors.	Students.	Schools.	Instructors.	Students.
United States	148	1,034	*7,343	102	1,155	†13,912	154	5,029	26,821
N. Atlantic Division.	52	448	2,915	18	275	4,598	26	1,136	6,514
S Atlantic Division.	19	128	903	21	159	2,138	23	574	3,609
S. Central Division	14	75	534	17	126	796	26	544	4,905
N. Central Division	58	357	2,910	39	537	5,851	67	2,412	10,693
Western Division	5	26	81	7	58	529	12	363	1,100

* 108 of these were women. † 165 of these were women.

GENERAL SUMMARY OF STATISTICS OF PROFESSIONAL AND ALLIED SCHOOLS FOR 1901-2.

Class.	Schools.	Instructors.	Students.	Graduates.
Theological	148	1,034	7,343	1,656
Law	102	1,155	13,912	3,524
Medical	154	5,029	26,821	5,069
Dental	56	1,197	8,420	2,288
Pharmaceutical	59	590	4,427	1,379
Veterinary	11	174	576	141
Nurse training	545	....	13,252	4,015
Total	1,075	9,179	74,751	18,072
Medical schools included above:				
Regular	123	4,084	24,447	4,576
Homeopathic	20	649	1,551	342
Eclectic and physio-medical	11	296	823	151
Total	154	5,029	26,821	5,069

ENROLLMENT IN SPECIAL SCHOOLS IN 1901-2.

City evening schools (estimated)	207,162
Business schools	137,247
Schools for defectives	28,827
Reform schools	35,247
Government Indian schools	24,120
Indian schools (five civilized tribes)	13,864
Schools in Alaska supported by the Government	1,741
Schools in Alaska supported by incorporated municipalities (partly estimated)	1,700
Orphan asylums and other benevolent institutions	15,000
Private kindergartens	105,932
Miscellaneous (including schools of music, oratory, elocution, cookery, and various special arts	50,000
Total	620,840

SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1900.

VOLUMES AND PAMPHLETS ADDED AND BOOKS ISSUED.

Division.	Periodicals.		Volumes Added During the Year.		Pamphlets Added During the Year.		Books Issued for Home Use.		Books Issued for Use in Library.	
	Libraries Reporting.	Number.	Libraries Reporting.	Number.	Libraries Reporting.	Number.	Libraries Reporting.	Number.	Libraries Reporting.	Number.
United States	3,036	209,412	3,684	2,156,992	1,455	549,326	2,405	48,410,128	783	9,609,632
N. Atlantic Div.	1,352	118,731	1,787	1,128,085	580	269,322	1,347	27,105,291	386	3,979,467
S. Atlantic Div.	245	19,639	265	175,323	122	67,117	117	1,726,203	48	802,769
S. Central Div.	191	6,034	202	73,320	118	29,914	75	420,470	44	165,555
N. Central Div.	1,010	51,258	1,161	630,959	508	139,820	711	15,358,076	243	3,754,728
Western Div.	238	13,750	269	194,305	127	43,153	155	3,800,088	62	907,113

SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1900.

SOURCES OF SUPPORT.—CLASSIFICATION.

Division.	Own or Rent Buildings.			Supported by Taxation or by Corporation.			Free or Subscription.			Circulating or Reference.		
	Own.	Rent.	Not Reporting.	By Taxation.	By Corporation.	By Both.	Free.	Free for Reference.	Subscription.	Circulating.	Reference.	Both.
United States	1,040	592	3,751	2,375	2,870	138	2,734	1,735	914	447	1,148	3,788
N. Atlan. Div.	612	286	1,575	1,029	1,329	115	1,417	701	355	251	459	1,763
S. Atlan. Div.	54	23	344	113	302	6	88	233	100	21	128	272
S. Cent. Div..	44	19	311	94	269	11	85	191	98	14	124	236
N. Cent. Div.	293	203	1,232	931	793	4	946	486	296	141	341	1,246
Western Div.	37	61	289	208	177	2	198	124	65	20	96	271

SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1900.

GENERAL CLASSIFICATION OF LIBRARIES.

Division.	General.	School.	College.	College Society.	Law.	Theological.	Medical.	Government.	State.	Asylum, etc.	Young Men's Christian Association.	Masonic.	Independent Order of Odd Fellows.	Other Society.	Scientific.	Historical.	Garrison.	Mercantile.
United States	1,979	1,725	689	53	162	120	63	35	43	65	82	19	15	160	83	63	11	16
N. Atlan. Div.	1,172	696	117	23	74	57	31	2	6	34	53	3	2	107	41	39	5	11
S. Atlan. Div.	67	120	112	10	17	13	8	28	5	3	8	4	2	10	8	5	1	..
S. Cent. Div..	50	137	133	8	8	6	3	1	8	3	4	4	2	5	1	..	1	..
N. Cent. Div..	576	634	276	12	37	38	17	3	18	22	13	4	5	28	25	15	2	3
West. Div....	114	138	51	..	26	6	4	1	6	3	4	4	4	10	8	4	2	2

SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1900.

CLASSIFICATION ACCORDING TO SIZE.

Division.	Number of Volumes to a Library.							
	500,000 and over.	300,000 to 499,999.	100,000 to 299,999.	50,000 to 99,999.	25,000 to 49,999.	10,000 to 24,999.	5,000 to 9,999.	1,000 to 4,999.
United States..	4	3	47	90	193	526	866	3,654
N. Atlantic Div.	3	2	24	53	100	242	429	1,620
S. Atlantic Div.	1	....	5	11	23	60	73	248
S. Central Div..	....	....	1	3	11	26	46	287
N. Central Div..	....	1	13	18	46	162	262	1,226
Western Div....	....	....	4	5	13	36	56	273

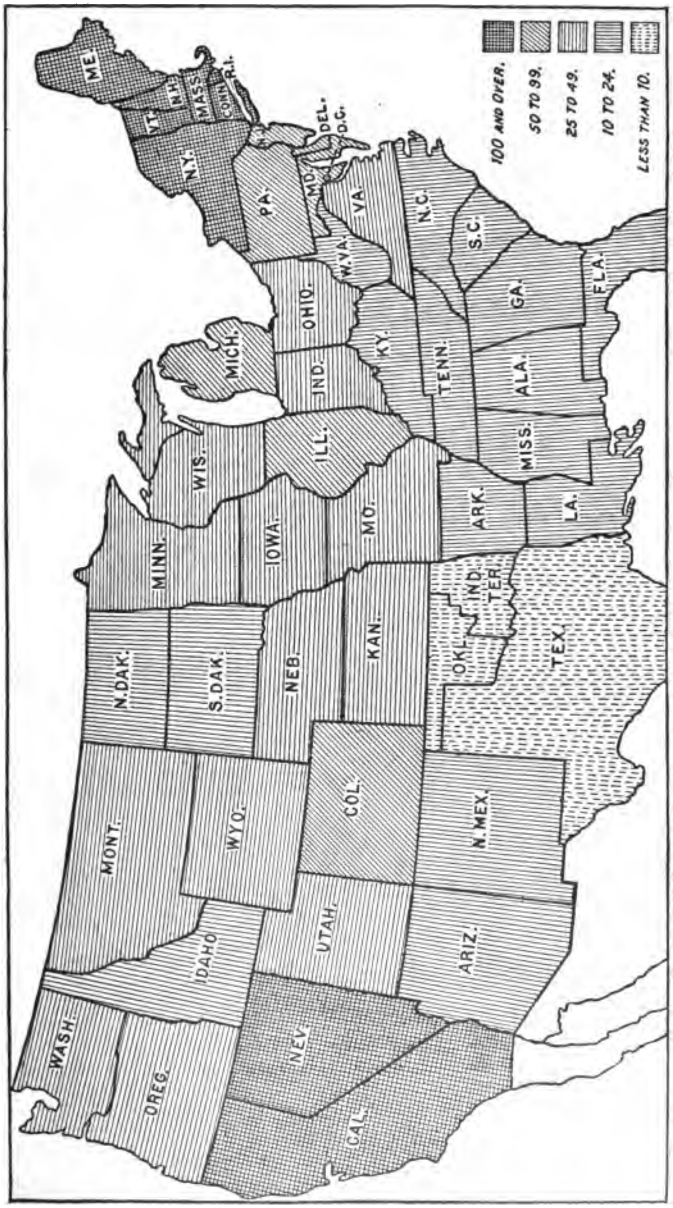


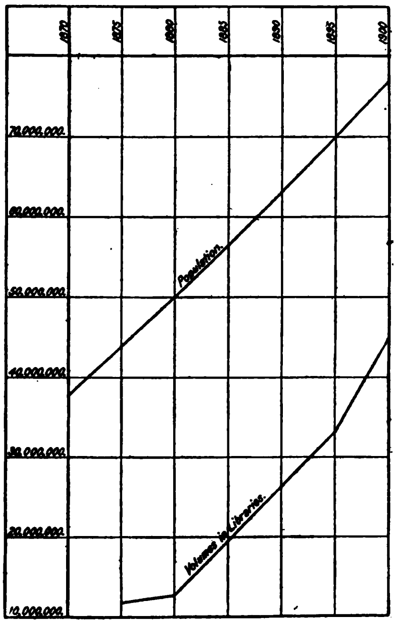
CHART SHOWING RELATIVE NUMBER OF VOLUMES TO EACH 100 POPULATION IN 1900.

SUMMARY OF STATISTICS OF PUBLIC, SOCIETY, AND SCHOOL LIBRARIES OF 1,000 VOLUMES AND OVER IN 1900.

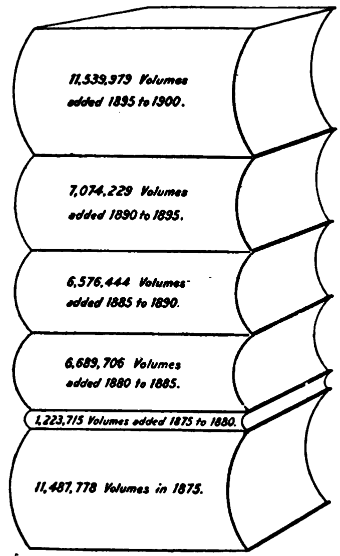
DISTRIBUTION OF LIBRARIES AND VOLUMES.

Division.	Libraries.	Volumes.	Population, Census of 1900.	Number of People per Library.	Books per 100 of Population.
United States........	5,383	44,591,851	75,997,687	14,118	59
North Atlantic Div....	2,473	23,410,577	21,045,748	8,510	111
South Atlantic Div....	421	5,303,237	10,445,486	24,811	51
South Central Div.....	374	1,886,731	14,079,861	37,647	13
North Central Div. ...	1,728	11,211,710	26,335,243	15,240	43
Western Division.....	387	2,779,596	4,091,349	10,572	68

—*From Reports of the Bureau of Education.*



THE RELATION OF LIBRARIES TO POPULATION.

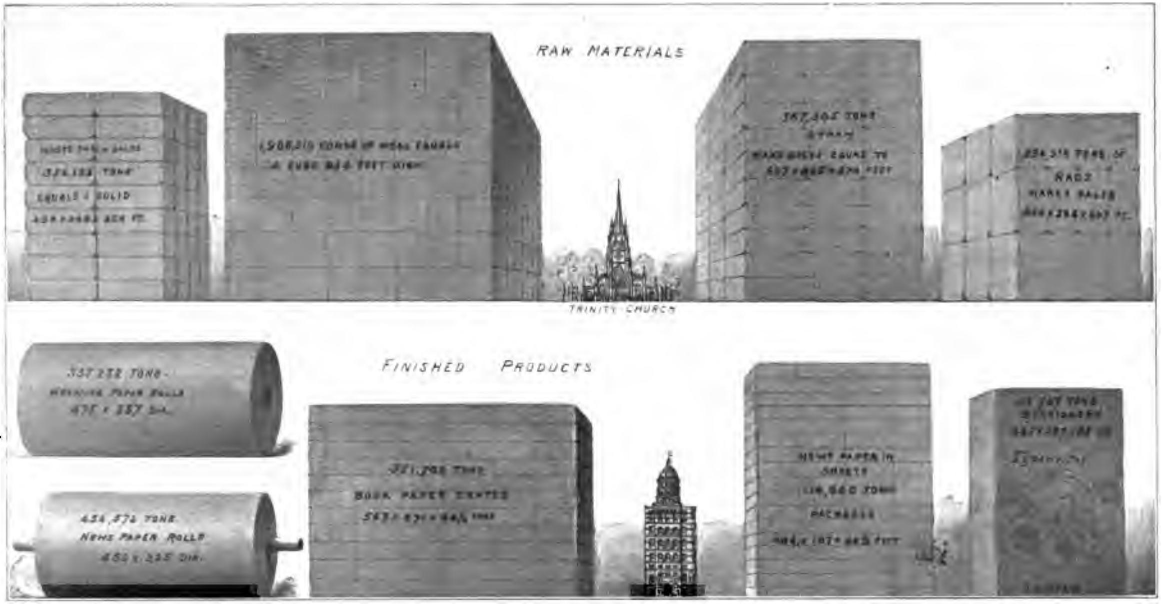


IN 5,383 LIBRARIES THERE WERE IN 1900, 44,591,851 VOLUMES.

PRINTING AND PUBLISHING.

There were 18,226 publications reported to the census authorities, while 3,046 publications failed to report. This would give a remarkable total of 21,272 periodicals, and the aggregate circulation of those reporting was 114,229,334 per issue, while the aggregate number of copies issued during the census year was 8,168,148,749.

The average capital of those engaged in the printing business is $12,574; the average value of their products is $14,569. These figures compared with those of a previous decade show that in a period of ten years an increased capital is required to produce the same or even a smaller value of products; this is largely caused by an



A GRAPHICAL COMPARISON OF RAW AND FINISHED PRODUCTS CONSUMED ANNUALLY IN THE MANUFACTURE OF BOOKS AND PERIODICALS IN THE UNITED STATES.

When figures get beyond a certain point they lose their concrete value, and it is necessary to resort to some other means if we wish to make comparisons involving figures that run up into millions and billions. Therefore, we adopt the method of representing these figures by comparisons of bulk and form. The basis for the comparison which we have worked out is the Twelfth Census of the United States, viz: that of 1900.

increase in wages and a decrease in working hours. In 1850 a compositor in New York received $9 per week; ordinary job compositors now receive $19.50 per week, and operators on machines from $24 to $27, depending on the time of day or night they take their shift. In the opinion of many large operators, the number of wage earners has actually increased rather than diminished. The introduction of machine composition has been of decided benefit to the employee, offering a new field for endeavor. There are few unemployed men in the printing trade, as is shown by the fact that when in 1900 the Typographical Union was called upon to supply 150 men for a special job of city printing, only 100 could be obtained, and these with difficulty.

A classified list of periodicals is given below, showing how the list is divided:

Period of issue:

Daily	2,226
Tri-weekly	62
Semi-weekly	637
Weekly	12,979
Monthly	1,817
Quarterly	237
All other classes	268
Total	18,226

Character of publication:

News, politics, and family reading	14,867
Religion	952
Agriculture, horticulture, dairying, and stock-raising	307
Commerce, finance, insurance, railroads, and trade	710
General literature, including magazines	239
Medicine and surgery	111
Law	62
Science and mechanics	66
Fraternal organizations	200
Education and history	259
Society, art, music and fashion	88
Miscellaneous	365

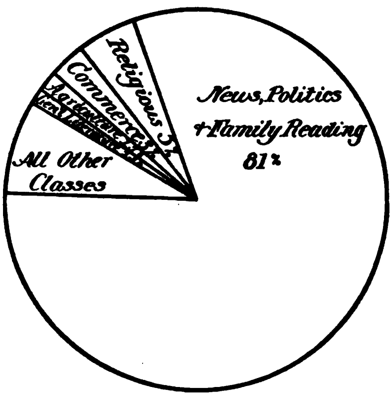
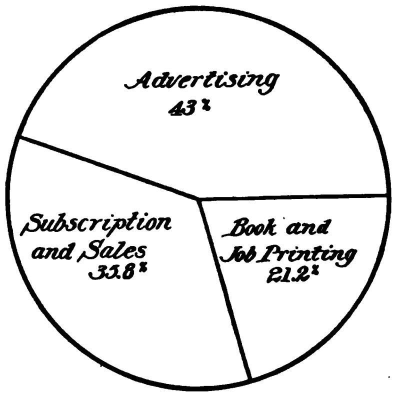
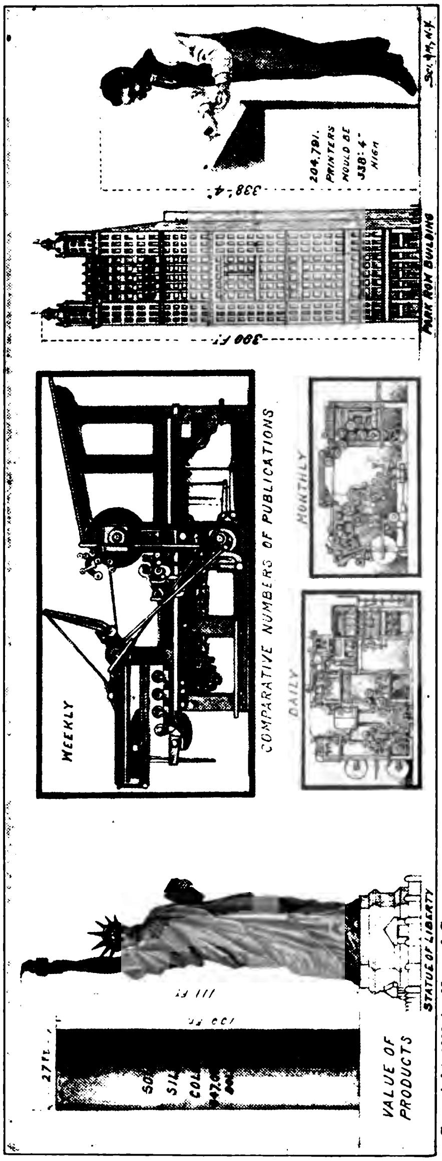


DIAGRAM SHOWING CLASSIFICATION OF PAPERS.



PROPORTION WHICH ADVERTISING, SUBSCRIPTION AND SALES, AND BOOK AND JOB PRINTING FORM OF THE TOTAL VALUE OF ALL PRODUCTS.

Out of the 18,226 publications, 2,226 are dailies, with a circulation of 15,102,156; 62 are tri-weekly, with a circulation of 228,610; 637 are semi-weekly, with a circulation of 2,832,-868; 12,979 papers are issued weekly, with a circulation of 39,852,052. There are 1,817 monthly publications, whose circulation is 39,519,897. The quarterly publications are mostly devoted to special subjects, and only number 237, but their circulation is very respectable, as they issue 11,217-422 per number. Semi-monthly, semi-annual and yearly publications number 268, and have a circulation of 5,-541,329. Out of 18,226 publications, 17,194 were printed in English.



COMPARISON SHOWING NUMBER OF PUBLICATIONS, VALUE OF PRODUCT AND LABOR.

In 1900, cities of 201,000 inhabitants and over contained 79 per cent of the separate job-printing establishments of the country, and 97.7 per cent of the total job product emanated from them.

Ayer's Newspaper Directory for 1904 gives later figures, viz.: Daily, 2,457; tri-weekly, 56; semi-weekly, 634; weekly, 16,935; fortnightly, 65; semi-monthly, 285; monthly, 2,698; bimonthly, 53; quarterly, 192; miscellaneous, 10. Total, 23,385.

QUANTITY AND COST OF PAPER USED.

Kinds.	Pounds	Cost.	Average cost per pound. cents.
News	956,335,921	$22,197,0‿0	2.3
Book and periodical	202,196,263	9,356,490	4.5
Job printing	74,510,064	6,270,306	8.4
Total	1,233,142,248	$37,823,856	3.1

Our figures show the quantity and cost of paper used and the average cost per pound in 1900.

In this table is presented a division of the paper used in 1900, according to the several classes of products which, combined, produced the total value of products of newspaper and periodical establishments. About one and a quarter billions of pounds was used during the year in which the census was undertaken. This large quantity was utilized in the following proportions:

	Per cent.
News	77.6
Book and periodical	16.4
Job printing	6.0

LIBRARIES OF THE WORLD.

The following is a list of the principal Libraries of the world:

Library.	City.	No. of Vols.
Bibliothèque nationale	Paris	2,602,000
British Museum	London	2,003,000
Imper. publicnaja biblioteka	St. Petersburg	1,329,000
Königliche bibliothek	Berlin	1,200,000
Library of Congress	Washington	1,000,000
Kön. Hof- u. Staatsbibliothek	Munich	1,000,000
K. u. k. Hofbibliothek	Vienna	900,000
Universitäts- u. landesbibliothek	Strasburg	814,000
Public Library	Boston	812,260
Publicnyj i Rumjancovskij musej	Moscow	800,000
Public Library—Astor, Lenox, and Tilden Foundation	New York City	787,700
Biblioteca nacional	Madrid	600,000
Bodleian Library	Oxford	600,000
K. k. Universitäts-bibliothek	Vienna	596,526
Harvard University Library	Cambridge (U. S.)	575,889
Cambridge University Library	Cambridge (Eng.)	550,000
Det store kongelige bibliothek	Copenhagen	550,000
Universitäts-bibliothek	Göttingen	506,814
Universiteit bibliotheek	Amsterdam	500,000
Kön. bibliotheek	The Hague	500,000

THE RAPID EXTENSION IN THE GATHERING OF NEWS.

In 1886 the New York World reported the battle of Majuba Hill in six lines, but so rapid was the extension of news gathering that, fourteen years later, events in the same quarter of the globe were reported to the great American dailies by cable as fully as though close at hand. The destruction of St. Pierre, Martinique, in 1902, by an eruption of Mont Pelée, may be mentioned as an illustration of this tendency.

The cablegrams which detailed that great disaster reached American newspapers by way of Brazil, the Azores and Great Britain, costing the recipients from $2 to $4 per word, with fees for precedence.

CHAPTER VIII.

TELEGRAPHS, TELEPHONES, SUBMARINE CABLES, WIRELESS TELEGRAPHY, AND SIGNALING.

LAND LINES OF THE WORLD.

Below are given such particulars as we have been able to obtain of the land lines of telegraphs throughout the world, corrected up to December 31, 1903:

Countries.	Length of Lines in Miles.			Length of Conductors in Miles.			Pneumatic Tubes (Yds.).
	Aerial.	Underground.	Total.	Aerial.	Underground.	Total.	
African Transcont'ntal Tel. Co.	1,595	......	1,595	1,595	......	1,595	......
Austria	21,523	104	21,627	69,404	1,579	70,983	83,406
Bahamas	6	......	6	......	......	......	......
Belgium	4,041	9	4,050	21,318	253	21,571	3,352
Bolivia	1,795	......	1,795	......	......	......	......
Bosnia-Herzegovina	1,762	......	1,762	3,807	......	3,807	......
Brazil	14,677	......	14,677	27,670	......	27,670	......
British East Africa	120	......	120	126	......	126	......
British Guiana	312	......	312	1,234	......	1,234	......
British India (India Office)	55,055	......	55,055	181,883	......	181,883	......
British North Borneo	599	......	599	......	......	......	......
British South Africa	4,765	......	4,765	4,765	......	4,765	......
Bulgaria	3,263	1	3,264	6,835	......	6,835	......
Canada—Gt. N.-West. Tel. Co.	18,286	......	18,286	34,794	......	34,794	......
Canadian Pacific Telegraphs	9,900	2	9,902	44,685	57	44,742	......
Western Union Tel. Co.	2,756	28	2,784	13,025	44	13,069	......
Government Tel. Service	5,481	......	5,481	5,481	......	5,481	......
Cape Colony	8,018	11	8,029	28,763	2,190	30,953	......
Ceylon	1,519	......	1,519	2,721	......	2,721	......
Chile	7,473	......	7,473	13,344	......	13,344	......
China	14,000	......	14,000	......	......	......	......
Corea	1,200	......	1,200	1,350	......	1,350	......
Costa Rica	835	......	835	......	......	......	......
Denmark	3,811	7	3,818	12,538	472	13,010	......
Dutch Indies	5,459	15	5,474	8,070	41	8,111	......
Ecuador	2,070	......	2,070	......	......	......	......
Egypt	2,538	......	2,538	10,755	......	10,755	......
France, Continent and Corsica	55,157	3,997	59,154	196,657	13,858	210,515	288,828
" Algeria	4,445	16	4,461	10,417	166	10,583	......
French Guiana (Cayenne)	171	......	171	171	......	171	......
French Indo-China (Cochin-China, Cambodia, Annam, Tonkin, and Laos)	7,587	39	7,626	13,422	68	13,490	......
Germany	77,828	3,953	81,781	276,684	27,116	303,800	180,204
Great Britain and Ireland	43,023	1,768	44,791	305,366	104,012	409,378	114,400
Greece	5,717	1	5,718	8,590	1	8,591	......
Holland	3,779	229	4,008	15,397	761	16,158	1,004
Hungary	23,036	33	23,069	117,154	2,498	119,652	......
Indo-European Persian Gulf System (Mekran Coast)	698	......	698	1,392	......	1,392	......
Indo-European Teheran, Bushire Line	693	......	693	2,079	......	2,079	......
Italy	24,370	......	24,370	94,225	......	94,225	......
[1] Japan	16,374	7	16,381	78,264	680	78,944	......

[1] Exclusive of 20.148 nautical miles of river cables and 39.031 miles of conductors.

LAND LINES OF THE WORLD—*Continued.*

Countries.	Length of Lines in Miles.			Length of Conductors in Miles.			Pneumatic Tubes (Yds.).
	Aerial.	Underground.	Total.	Aerial.	Underground.	Total.	
Luxemburg	259	....	259	508	....	508	....
Malay States (Federated)	969	....	969	460	....	1,429	....
Mauritius	141	....	141	316	....	316	....
[1] Mexico	20,258	....	20,258	31,454	....	31,454	....
Natal	1,722	....	1,722	4,678	....	4,678	....
Netherlands East India	12,441	....	12,441	....	....	....	....
New South Wales	14,430	95	14,525	53,671	4,946	58,617	....
New Zealand	7,749	....	7,749	22,672	....	22,672	....
Nicaragua	1,694	....	1,694	2,326	....	2,326	....
North American Tel. Co.	1,074	....	1,074	2,306	....	2,306	....
Norway	5,479	....	5,479	11,402	....	11,402	44
[2] Peru	2,716	....	2,716	2,820	....	2,820	....
Portugal	5,298	....	5,298	11,669	....	11,669	....
Queensland	10,269	....	10,269	20,806	....	20,806	....
Roumania	3,439	9	3,448	7,388	41	7,429	....
Russia	76,484	192	76,676	177,148	427	177,575	....
Senegal	1,501	11	1,512	2,038	11	2,049	....
Servia	1,689	....	1,689	3,863	....	3,863	....
South Australia	5,783	....	5,783	18,467	....	18,467	....
Southern Rhodesia	2,233	....	2,233	4,496	....	4,496	....
Spain	24,481	366	24,847	48,749	323	49,072	....
Sudan Provinces	3,052	....	3,052	3,451	....	3,451	....
Sweden	5,699	5	5,704	17,609	60	17,669	....
Switzerland	3,907	58	3,965	12,912	1,745	14,657	....
Tasmania	1,778	....	1,778	2,803	6	2,809	....
Tunis	1,398	5	1,403	2,537	5	2,542	....
Turkey	24,831	....	24,831	39,519	....	39,519	....
Uganda Protectorate	246	....	246	246	....	246	....
" State Rly. Telegraphs	950	....	590	1,762	....	1,762	....
United States of America:							
Commercial Cable Co.	27,344	153	27,497	192,566	7,829	200,395	4,900
[3] Western Union Company	184,636	252	184,888	1,050,186	15,211	1,065,397	....
Victoria—Postal Department	4,001	1	4,002	9,894	38	9,932	3,697
" Rly. Department	2,588	....	2,588	3,795	....	3,795	....
Western Australia	6,066	....	6,066	9,118	....	9,118	....
Total	922,342	11,367	933,709	3,387,716	184,438	3,572,154	679,835

[1] Inclusive of 535 miles of lines and 569 miles of conductors belonging to the Peruvian Corporation.

[2] Exclusive of 811 miles of miscellaneous subaqueous cables and 2,320 miles of conductors.

[3] Exclusive of 404.6 nautical miles of cable in Gulf of Mexico.

—*Electrical Trades Directory.*

MILEAGE OF LINES AND WIRES, NUMBER OF OFFICES, AND TRAFFIC OF THE WESTERN UNION TELEGRAPH COMPANY.

Year Ending June 30—	Miles of Line.	Miles of Wire.	Number of Offices.	Number of Messages Sent.	Receipts.	Expenses.	Profits.	Average per Message.	
								Toll.	Cost.
					Dollars.	Dollars.	Dollars.	Cents.	Cents.
1868	50,183	97,594	3,219	6,404,595	7,004,560	4,362,849	2,641,711	104.7	63.4
1878	81,002	206,202	8,014	23,918,894	9,861,355	6,309,813	3,551,543	38.9	25.0
1888	171,375	616,248	17,241	51,463,955	19,711,164	14,640,592	5,070,572	31.2	23.2
1898	189,847	874,420	22,210	62,173,749	23,915,733	17,825,582	6,090,151	30.1	24.7
1903	196,517	1,089,212	23,120	*69,790,866	29,167,687	20,953,215	8,214,472	31.4	25.6

* Not including messages (probably 10,000,000) sent over leased wires or under railroad contracts.

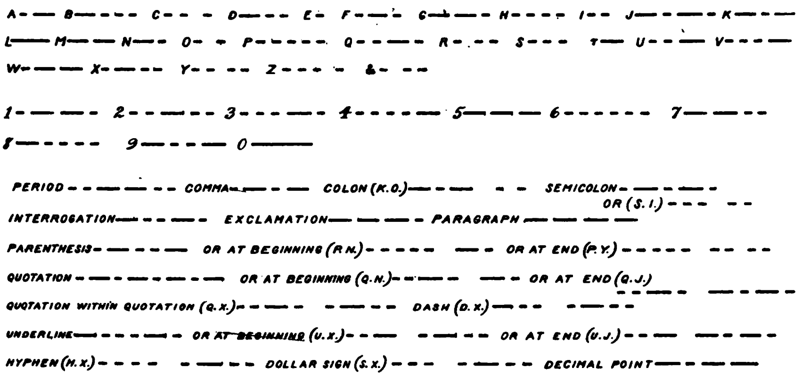
The greatly increased mileage since 1880 is principally due to the fact that in 1881 the Western Union Telegraph Company absorbed by purchase all the lines of the American Union and the Atlantic and Pacific Telegraph Companies, the former having previously in operation over 12,000 miles of line and the latter 8,706 miles. Capital stock of the Western Union, $100,000,000.

The Western Union has exclusive contracts with several international cable companies, operating eight Atlantic cables, and guarantees 5 per cent annual dividends on the stock of the American Telegraph and Cable Company; amount $14,000,000.

Besides the above, there are new lines of telegraph which have complied with the United States telegraph act of 1866, and are operating wires with or without connection with railway companies in many parts of the country.—*Statistical Abstract of the United States.*

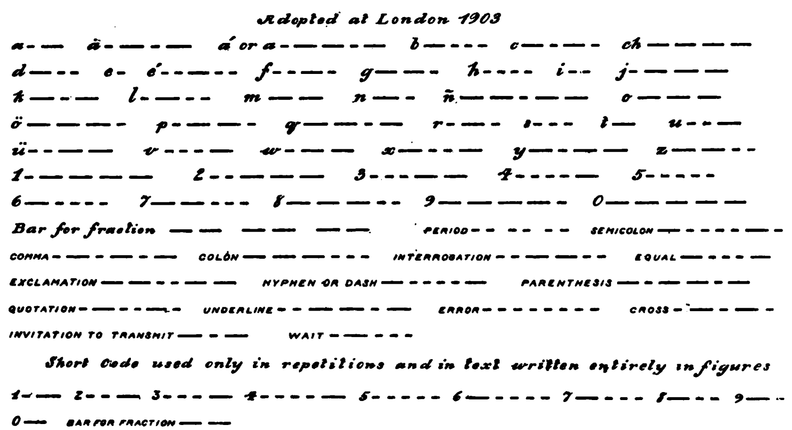
THE MORSE TELEGRAPH CODE.

(Used in the United States.)



THE INTERNATIONAL TELEGRAPH CODE.

(The Cable Code.)



MILEAGE OF LINES AND WIRES, NUMBER OF OFFICES, AND MESSAGES SENT, OF THE POSTAL TELEGRAPH CABLE COMPANY.

Year.	Miles of Poles and Cable Operated but not Owned.	Miles of Poles and Cable Owned.	Miles of Wires.	Offices.	Messages.
1335	....	2,811	23,587	260	1,428,690
1897	16,011	21,098	178,438	9,875	13,628,064
1903	21,319	27,482	276,245	19,977	21,600,577

The aggregate mileage of telegraph lines which carry varying numbers of wires, according to the business requirements of the localities through which they run, in the United States open for public business exceeds 210,000 miles, besides railways, Government, private and telephonic lines; the length of the latter not being ascertainable.

STATISTICS OF THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY AND OPERATING COMPANIES ASSOCIATED WITH IT ON JANUARY 1, FROM 1897 TO 1903.

Data.	1897.	1900.	1903.
Exchanges	967	1,239	1,514
Branch offices	832	1,187	1,861
Miles of wire:			
On poles	286,632	509,036	[1] 1,109,017
On buildings	12,594	15,087	
Underground	234,801	489,250	1,328,685
Submarine	2,818	3,404	6,048
Total miles of exchange service wire	536,845	1,016,777	2,443,750
Total circuits	264,645	422,620	742,654
Total employees	14,425	25,741	50,350
Total subscribers	325,244	632,946	1,277,983
Length of wire operated ... miles	805,711	1,518,609	3,281,662
Instruments in hands of licensees under rental at beginning of year ... No.	772,627	1,580,101	3,150,320
Daily exchange connections ... "	2,630,071	5,173,803	9,322,951
Average daily calls per subscriber ... "	8.3	8.2	7.3
Received in rentals of telephones ... dollars	1,597,959	2,427,038	....
Dividends paid stockholders ... "	3,682,949	4,078,601	....
Capital ... "	....	89,100,500	....
Gross earnings ... "	5,130,845	9,534,499	....
Net earnings ... "	4,169,675	5,486,058	....

[1] Information not collected separately.

TELEGRAPHIC TIME SIGNALS SENT OUT AT NOON DAILY, EXCEPT SUNDAYS AND HOLIDAYS, BY THE U. S. NAVAL OBSERVATORY.

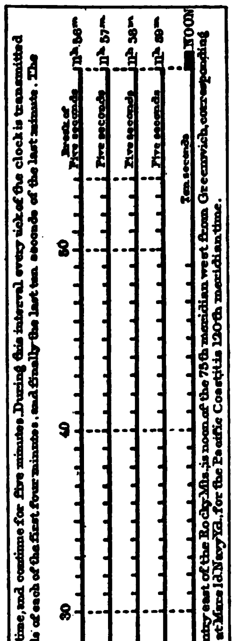
The time service of the U. S. Naval Observatory has continued regularly to send out daily telegraphic time signals at noon, seventy-fifth meridian time, with an average error for the year of only 0^s 15. The widespread importance of this service is shown by the fact that it furnishes absolute standard time not only for navigators at all the principal seaports, but for the entire country except the Pacific Coast, which gets a similar signal from the Naval

Observatory at the Mare Island Yard. Moreover, all of this invaluable service is rendered to the country at no expense whatever to the Government, inasmuch as it is merely incidental to the work and facilities required for the rating of chronometers for naval vessels.

To illustrate the wide distribution of this time signal, it is of interest to record the fact that it goes out daily over the wires of the Western Union Telegraph Company, the Postal Telegraph Company, the American Telephone and Telegraph Company, the electrical department of the District of Columbia, and the National Electric Supply Company. There are now 18 Government time-balls and some 40,000 public and private clocks corrected daily by naval time signals.

The entire series of noon signals sent out daily over the wires is shown graphically in the accompanying diagram. This represents the signals as they would be recorded on a chronograph, where a pen draws a line upon a sheet of paper moving along at a uniform rate beneath it, and is actuated by an electro-magnet so as to make a jog at every tick of the transmitting clock. The electric connections of the clock are such as to omit certain seconds, as shown by the breaks in the record. These breaks enable anyone who is listening to a sounder in a telegraph or telephone office to recognize the middle and end of each minute, especially the end of the last minute, when there is a longer interval that is followed by the noon signal. During this last long interval, or 10-second break, those who are in charge of time balls and of clocks that are corrected electrically at noon throw their local lines into circuit so that the noon signal drops the time balls and corrects the clocks.

This series of noon signals is sent continuously over the wires all over the United States for an interval of five minutes immediately preceding noon. For the country east of the Rocky Mountains the signals are sent out by the Observatory at Washington and end at noon of the 75th meridian, standard time, corresponding to 11 a. m. of the 90th meridian and 10 a. m. of the 105th meridian. For the country west of the Rocky Mountains they are sent out by the Observatory at the Mare Island Navy Yard, California, and end at noon of the 120th meridian, the standard time meridian of the Pacific Coast. The transmitting clock



TELEGRAPHIC TIME SIGNALS AS SENT OUT BY THE U. S. NAVAL OBSERVATORY.

that sends out the signals is corrected very accurately, shortly before noon, from the mean of three standard clocks that are rated by star sights with a meridian transit instrument. The noon signal is seldom in error to an amount greater than one or two tenths of a second, although a tenth more may be added by the relays in use on long telegraph lines. Electric transmission over a continuous wire is practically instantaneous. For time signals at other times than noon, similar signals can be sent out by telegraph or telephone from the same clock that sends out the noon signal.

STANDARD TIME

The desirability of using a uniform standard of time, independent of local time, was recognized at a very early date. The differences of local time arise from the use of solar motion as a time-measurer. We call the time noon when the sun is opposite the meridian of the place where we are living, and in consequence of the sun's motion from east to west, the more easterly of two places will have the earlier time, the difference in hours being exactly 1-15th of the longitudinal difference in degrees. In other words, 15 degrees of longitude correspond to a time difference of one hour. Peculiar difficulties were encountered in this country on account of its vast longitudinal extent, and the inconvenience became very serious with the extension of the railroad and telegraph systems.

The movement which resulted in the adoption of the present time system may be said to have originated in a report on the subject by the American Meteorological Society, which was submitted at a meeting of the General Time Convention held on Oct. 13, 1881, proposing a single standard for the whole country and suggesting the hour theory as an alternative proposition. The matter was referred to the secretary, Mr. W. T. Allen, and communications were invited from parties interested. The proposal to fix one standard of time for the whole country was supported by many competent authorities; but, although there was much to recommend it from a scientific point of view, it was found to be impracticable on account of the many discrepancies which would occur between time by the clock and solar time. The system which found most favor, and was finally adopted, proposed the division of the country into four time sections, each of 15 degrees longitude (7½ degrees or 30 minutes on each side of the meridian), commencing with the 75th meridian. Inside each of these sections time was to be uniform, the time of each section differing from that next to it by exactly one hour. A scheme was drawn up in accordance with these principles, and at a meeting of the convention held in April, 1883, the following resolutions were adopted:

(1.) That all roads now using Boston, New York, Philadelphia, Baltimore, Toronto, Hamilton, or Washington time as standard, based upon meridians east of those points or adjacent thereto, shall be governed by the 75th meridian or Eastern time (4 minutes slower than New York time.)

(2.) That all roads now using Columbus, Savannah, Atlanta, Cincinnati, Louisville, Indianapolis, Chicago, Jefferson City, St. Paul, or Kansas City time, or standards based upon meridians adjacent thereto, shall be run by the 90th meridian time, to be called Central time, one hour slower than Eastern time and 9 minutes slower than Chicago time.

(3.) That west of the above-named sections the roads shall be run by the 105th and the 120th meridian times respectively, two and three hours slower than Eastern time.

(4.) That all changes from one hour standard to another shall be made at the termini of roads or at the ends of divisions.

The advantages of this method of reckoning time are obvious. Every town, instead of regulating its business by its own local time, uses the time of the nearest of the standard meridians, and the difference in time in actual use in any two cities will be an exact number of hours, instead of a number of hours, minutes and seconds. A traveler, therefore, wishing to reset his watch, need only change the hour, without paying any attention to the minutes. Having proceeded, *e. g.*, from New York to any town within the Central time zone, he has simply to set his watch one hour slow of New York time, and need not compare it with any of the local clocks.

STANDARD TIME IN THE UNITED STATES.

VARIATION OF TIME IN DIFFERENT COUNTRIES.

NOTE.—Hours of the night, **6** p.m. to **5.59** a.m., are in dark type.

Trains in Great Britain, Belgium, Holland, and Spain run on Greenwich (West Europe) time; in Switzerland, Italy, Denmark, Sweden, Germany, Austria, and Servia, on Mid-European time (one hour fast of Greenwich); in France at 5 minutes behind Paris time (see below); and in Roumania, Bulgaria, and part of Turkey, on East European time (two hours faster than Greenwich).

Outside clocks at French stations show Paris time, but inside clocks—by which trains are worked—are 5 minutes slower than outside. Thus there is only 4 minutes 20.6 seconds difference between English and French railway time.—*Cook's Continental Time Tables.*

IT IS THE FOLLOWING TIME AT

WHEN IT IS 12 NOON AT	Mean Time of	Amsterdam (local time).	Athens.	Berlin (local time).	Berne (local time).	Brussels (local time).	Budapest (local time).	Cairo.	Christiania.	Cologne (local time).	Copenhagen (local time).	East European Time.	Greenwich.
		no'n	p.m.	p.m.	p.m.	a.m.	p.m.	p.m.	p.m.	p.m.	p.m.	p.m.	a.m.
Amsterdam.	....	12 0	1 15	12 34	12 10	11 35	12 57	1 40	12 30	12 8	12 31	1 40	11 40
Athens.	Greece	....	12 0	....	....	....	....	....	....	....	....	12 45	10 25
Berlin.	....	11 26	12 41	12 0	11 36	11 24	12 23	....	....	11 34	11 57	1 6	11 6
Berne.	....	11 50	1 5	12 24	12 0	11 48	12 46	....	....	11 58	12 20	1 30	11 30
Brussels.	....	12 2	1 17	12 36	12 12	12 0	12 59	....	....	12 10	12 33	1 43	11 43
Cairo.	Egypt	....	11 55	....	....	....	....	12 0	....	....	....	12 20	10 20
Christiania.	Norway	....	1 5	....	....	....	....	....	12 0	....	....	1 30	11 30
Cologne.	Rhine	11 52	1 7	12 26	12 2	11 50	12 48	....	....	12 0	12 22	1 32	11 32
Constant'ple.	....	10 24	11 51	10 58	10 34	10 22	11 20	....	....	10 32	10 54	12 4	10 4
Copenhagen.	....	11 29	12 44	12 3	11 40	11 27	12 26	....	....	11 38	12 0	1 10	11 10
Dublin.	Ireland	12 45	2 0	....	....	....	....	....	....	....	....	2 25	12 25
East European time.	See above	10 20	11 35	10 54	10 30	10 17	11 16	12 0	10 50	10 28	10 50	....	10 0
Greenwich.	Englnd	12 20	1 35	12 54	12 30	12 17	1 16	2 5	12 50	12 28	12 50	2 0	12 0
Jerusalem.	Palest.	9 59	11 14	10 33	10 9	9 56	10 55	11 39	10 29	10 7	10 29	11 30	9 39
Lisbon.	Portug.	12 56	2 1	1 30	1 6	12 54	1 53	....	....	1 4	1 27	2 37	12 37
Madrid.	....	12 34	....	1 8	12 45	12 32	1 31	....	....	12 43	1 5	2 15	12 15
Melbourne.	Victoria	....	....	....	....	....	....	....	....	....	....	**4 20**	2 20
Mid-European time.	See above	11 20	12 35	11 54	11 30	11 17	12 16	1 0	11 50	11 28	11 50	1 0	11 0
Moscow.	....	9 49	....	10 23	10 0	9 47	10 46	....	....	9 58	10 20	10 30	9 30
Munich.	....	11 33	....	12 7	11 43	11 31	12 30	....	....	11 41	12 4	1 14	11 14
New York.	U. S.	5 16	....	5 50	5 29	5 14	**6 12**	....	....	5 24	5 46	**6 56**	4 56
Ottawa.	Canada.	....	....	....	....	....	....	....	....	....	....	**7 0**	5 0
Paris.	France	12 10	....	12 44	12 20	12 8	1 7	....	....	12 19	12 41	1 51	11 51
Rome.	....	11 30	....	12 4	11 40	11 28	12 26	....	....	11 38	12 0	1 10	11 10
S. Francisco.	Califor.	....	....	....	....	....	....	....	....	....	....	....	....
St. Petersb'rg	Russia	10 18	....	10 52	10 29	10 16	11 15	....	....	10 27	10 49	11 59	9 59
Stockholm.	....	11 7	....	11 41	11 18	11 5	12 4	....	....	11 16	11 38	12 48	10 48
Sydney.	N.S.W.	....	....	....	....	....	....	....	....	....	....	**3 55**	**1 55**
Vienna.	....	11 14	....	11 8	11 24	11 12	12 11	....	....	11 22	11 45	12 55	10 55

WHEN IT IS 12 NOON AT	Mean Time of	Jerusalem.	Melbourne.	Mid-European Time.	Munich (local time).	New York.	Ottawa.	Paris.	Rome (local time).	St. Petersburg.	Stockholm (local time).	Sydney.	Vienna (local time).
		p.m.	p.m.	p.m.	p.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	a.m.	p.m.
Amsterdam.	....	2 1	**9 20**	12 40	12 27	6 44	6 •40	11 50	12 30	1 42	12 53	9 45	12 46
Athens.	Greece	....	....	11 45	....	....	....	....	....	....	....	....	....
Berlin.	....	....	....	12 6	11 53	6 10	....	11 16	11 56	1 8	12 19	....	12 12
Berne.	....	....	....	12 30	12 17	6 34	....	11 40	12 20	1 31	12 42	....	12 36
Brussels.	....	....	....	12 43	12 29	6 47	....	11 52	12 32	1 44	12 55	....	12 48
Cairo.	Egypt	....	....	11 20	....	....	....	....	....	....	....	....	....
Christiania.	Norway	....	....	12 30	....	....	....	....	....	....	....	....	....
Cologne.	Rhine	....	....	12 32	12 19	6 36	....	11 42	12 22	1 33	12 44	....	12 38
Constant'ple.	....	....	....	11 4	10 51	5 8	....	10 13	10 54	12 5	11 16	....	11 10
Copenhagen.	....	....	....	12 10	11 56	6 14	....	11 19	12 0	1 11	12 22	....	12 15
Dublin.	Ireland	....	....	1 25	....	....	....	....	....	....	....	....	....
East European time.	See above	12 21	**7 40**	11 0	10 46	5 4	**5 0**	10 9	10 50	12 1	11 12	**8 5**	11 6
Greenwich.	Englnd	2 21	**9 40**	1 0	12 46	7 4	7 0	12 9	12 50	2 1	1 12	**10 5**	1 6
Jerusalem.	Palest.	12 0	**7 19**	10 39	10 23	4 43	**4 39**	9 48	10 29	11 40	10 51	**8 4**	10 45
Lisbon.	Portug.	....	....	1 37	1 23	7 41	....	12 46	1 27	2 38	1 49	....	1 42
Madrid.	....	....	....	1 15	1 1	7 19	....	12 24	1 5	2 16	1 27	....	1 20
Melbourne.	Victoria	....	12 0	**3 20**	....	....	....	....	....	....	....	....	....
Mid-European time.	See above	1 21	**8 40**	12 0	11 46	6 4	6 0	11 9	11 50	1 1	12 12	**9 5**	12 6
Moscow.	....	....	....	10 30	10 16	**4 34**	....	9 39	10 20	11 31	10 42	....	10 35
Munich.	....	....	....	12 14	12 0	6 18	....	11 23	12 4	1 15	12 26	....	12 19
New York.	U. S.	....	....	5 56	5 42	12 0	....	5 5	5 46	**6 57**	**6 8**	....	**6 2**
Ottawa.	Canada.	....	....	**6 0**	....	....	12 0	....	....	....	....	....	....
Paris.	France	....	....	12 51	12 37	6 55	....	12 0	12 41	1 52	1 3	....	12 56
Rome.	....	....	....	12 10	11 57	6 14	....	11 19	12 0	1 11	12 22	....	12 16
S. Francisco.	Califor.	....	....	....	....	....	....	....	....	....	....	....	....
St. Petersb'rg	Russia	....	....	10 59	10 45	**5 3**	....	10 8	10 49	12 0	11 12	....	11 4
Stockholm.	....	....	....	11 48	11 34	**5 52**	....	10 57	11 38	12 49	12 0	....	11 53
Sydney.	N.S.W.	....	....	**2 55**	....	....	....	....	....	....	....	12 0	....
Vienna.	....	....	....	11 55	11 41	**5 58**	....	11 4	11 45	12 56	12 7	....	12 0

SUBMARINE TELEGRAPHS.*

? The submarine telegraphs of the world number 1,815. Their aggregate length is nearly 221,292,441 miles; their total cost is estimated at $300,000,000, and the number of messages annually transmitted over them at more than 6,000,000. All the grand divisions of the earth are now connected by their wires, and from country to country and island to island the thoughts and words of mankind are instantaneously transmitted. Darkest Africa now converses daily with enlightened Europe or America, and the great events of the morning are known in the evening throughout the inhabited world. In August, 1902, authority was granted to the Commercial Pacific Cable Company of the United States to construct a cable line from the Pacific coast of the United States to the Hawaiian Islands, Guam, and the Philippine Islands, and the Asiatic coast, with a branch line to Japan. The first message was sent over it July 4, 1903.

The British Pacific cable was completed on October 31st and was opened for traffic on December 8th, 1902. The cable is "all British," and runs from Vancouver, on the west coast of Canada, to Fanning Island, Fiji, and Norfolk Island in the Pacific, and thence by means of two cables to New Zealand and Queensland respectively. Its total length is about 7,800 miles.

The developments in the construction, laying and operating of submarine cables and in their availability for general public use have quite kept pace with their extension throughout the civilized world. From a mere gutta-percha coated wire the submarine conductor of electricity has developed in a half century into a great cable having a central copper core surrounded by numerous layers of non-conducting material and protected by a steel wire wound spirally about it, and in turn further protected by waterproof and insect-proof wrappings. From a steamer-towed ocean barge the facilities for laying have developed to a fleet of nearly fifty steam vessels, with every facility for laying, picking-up, splicing, and repairing the cable lines. From a speed rate of three words per minute, which was made on the first trans-Atlantic cables, the speed of transmission has been accelerated to fifty words per minute, and even more than that, with the automatic transmitters now coming into use with cable lines, while by the duplexing of the cables their carrying capacity is doubled. From a cost to the sender of $100 per message, which was originally charged on the first trans-Atlantic cables, the rate from New York to London and the great cities on the continent of Europe has fallen to 25 cents per word. From several hours required for the transmission of a message and receipt of a response, the time has been so reduced that messages from the Executive Mansion to the battlefield at Santiago were sent and a response received within twelve minutes, while a message sent from the House of Representatives in Washington to the House of Parliament in London in the chess match of 1898 was transmitted and the reply received in thirteen and one-half seconds.

The effect of this ready and inexpensive method of transmitting thoughts and words from continent to continent throughout the civilized world is apparent in the rapid development of international commerce since it began. The first successful cable line between the United States and Europe was put into operation in 1866. In that year our commerce with Europe amounted to $652,232,289; in 1876, to $728,959,053; in 1886, to $898,911,504; in 1896, to $1,091,682,874, and in 1898, to $1,279,739,936, while our commerce with the whole world, which in 1866 amounted to $783,671,588, had by 1902 reached the enormous sum of $2,285,000,000.

During the last seven years Germany has laid 7,375 miles of ocean cables, at a cost of about $6,000,000. In 1898 a cable, 73 miles long, was laid between Sassnitz and Trelleborg, and German Southwest Africa was connected with the existing cable system by a line 154 miles long; and in 1900 the first German-American cable was laid between Emden and New York, by the Azores, a distance of 4,813 miles. About the same time the first German cables along the Chinese coast were laid; one of these was from Tsin-tau (Kiao-chau) to Chifu, 285 miles long, and the second connected the former place with Shanghai and is 438 miles. In 1901 a fifth cable connecting Germany and England was laid, as well as a

* From the Summary of Commerce and Finance for July, 1902. The figures are now somewhat larger.

telephone cable from Fehmarn to Laland. A second German cable to New York by the Azores has been commenced and will be completed before the end of 1904, while a line to Vigo, 1,300 miles in length, has been made. Germany is contemplating an extension of her cables by constructing lines between Alenado and Guam, in the Caroline Islands, and the Pelew Islands and Shanghai.

An International Telegraph Conference opened in London, May 26th, 1903, all the States adhering to the International Telegraph Convention being represented. The Conference revised the rules as to the use of code and cipher language in international telegraphy. The decision of the last Conference, that code telegraphy should, after a certain date, be limited to the words contained in the official vocabulary prepared by the International Telegraph Bureau, has been rescinded. In future, any combination of letters not exceeding ten in number will be passed as a code word, provided that it is pronounceable according to the usage of any of the languages to which code words have hitherto been limited—namely, English, French, German, Dutch, Italian, Spanish, Portu-

SUMMARY OF CABLES OWNED BY GOVERNMENT ADMINISTRATIONS.

Partly extracted from the Official Documents issued by the International Bureau of Telegraphic Administrations, Berne. With "The Electrician's" corrections to date and additions.

Country.	No. of Cables with One or More Cores.	Length in Nautical Miles.	
		Of Cables.	Of Conductors.
Argentine Republic	13	59.824	138.544
Austria	47	224.250	235.339
Bahamas	1	211.000	211.000
Belgium	[1] 2	54.514	279.856
Brazil	23	37.779	66.414
British Guiana	5	84.000	95.000
British India, Indo-European Telegraph Department Government Administration	157	2,168.013	1,711.885
Bulgaria	1	0.538	0.538
Canada	26	334.750	334.750
Ceylon and India (Joint)	2	66.300	66.300
China	1	113.000	113.000
Denmark	[1] 56	171.100	880.300
Dutch Indies	7	891.490	891.490
France and Algeria	[1] 56	4,913.824	5,847.200
France (West Africa)	3	1,567.238	1,567.238
French Indo-China (Cochin China, Tonquin, and Amoy)	2	1,697.326	1,697.326
Germany	[1] 89	2,796.695	5,654.977
Great Britain and Ireland	[1] 177	2,265.830	7,551.994
Greece	46	54.931	54.931
Holland	32	241.543	780.449
Inter-Colonial System	5	7,837.770	7,837.770
Italy	36	1,063.088	1,112.458
Japan	103	2,154.883	2,851.173
Macao	1	1.930	1.930
New Caledonia	1	1.000	1.000
New South Wales	147	51.789	108.459
New Zealand	16	285.682	290.466
Norway	322	291.489	375.787
Portugal	4	115.050	115.050
Queensland	19	52.100	67.520
Russia in Europe, and the Caucasus	12	328.282	408.387
Russia in Asia	1	70.157	70.157
Senegal	1	3.000	3.000
South Australia	3	49.360	49.360
Spain	15	1,771.346	1,771.346
Sweden	[1] 17	208.488	368.431
Switzerland	2	9.827	13.400
Tasmania	4	4.750	19.000
Turkey in Europe and Asia	21	346.558	368.734
Victoria	1	4.500	4.500
Western Australia	1	3.750	3.750
Total	1,378	32,609.748	44,006.813

Including half of Cables owned jointly with other Administrations.

guese, and Latin. Other combinations of letters will be counted at five letters to the word; the prohibition of letter cipher which has hitherto prevailed being removed. These alterations, together with a number of other changes in the detailed regulations, take effect on July 1st, 1904. The above information is taken from Reports of the Bureau of Statistics, Department of Commerce and Labor, and Hazell's Annual.

SUMMARY OF CABLES OWNED BY PRIVATE COMPANIES.

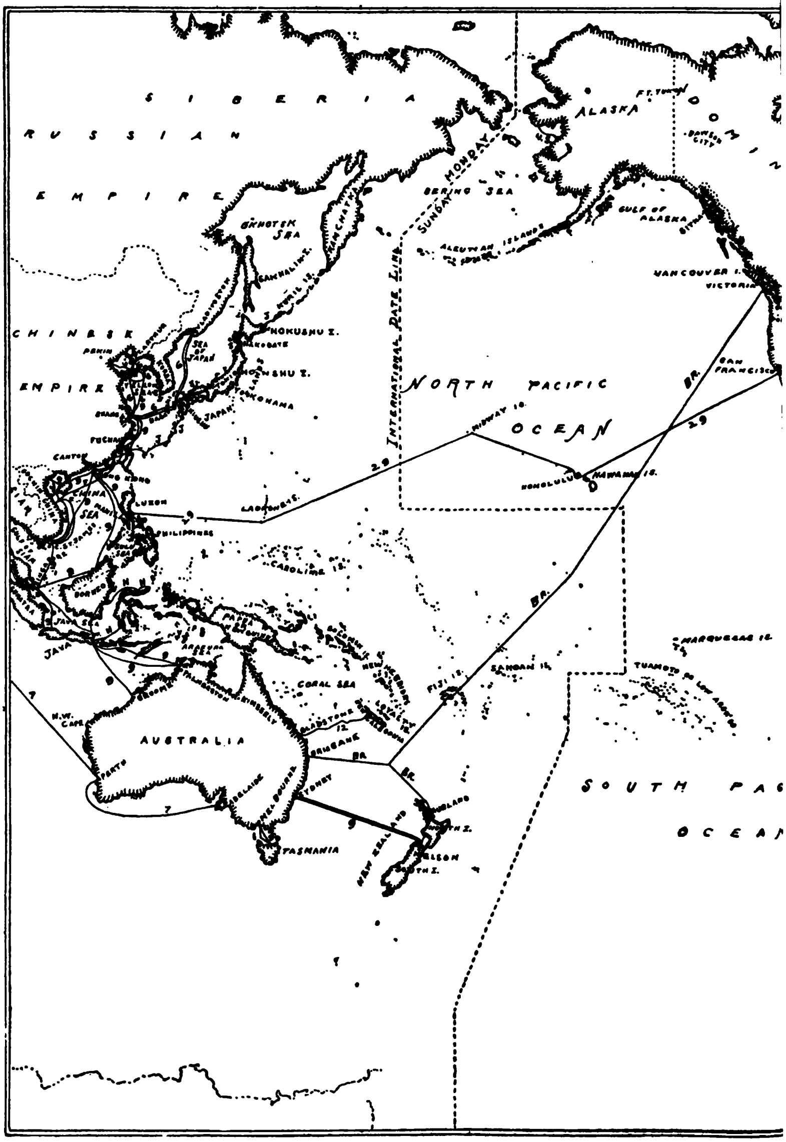
Private Companies.	No. of Cables with One or More Cores.	Length of Cables in Nautical Miles.
African Direct Telegraph Company	10	3,031.000
Amazon Telegraph Company	15	1,326.000
Anglo-American Telegraph Company	14	9,507.660
Black Sea Telegraph Company	1	337.147
Canadian Pacific Railroad Company	9	53.940
Central and South American Telegraph Company	15	7,500.500
Commercial Cable Company	11	13,212.310
Commercial Pacific	4	7,846.747
Compagnie Française des Câbles Télégraphiques	32	12,102.423
Cuba Submarine Telegraph Company	10	1,162.000
Deutsch Atlantische Telegraphen-Gesellschaft	3	6,057.868
Deutsche See-Telegraphen-Gesellschaft	1	1,111.979
Direct Spanish Telegraph Company	3	723.460
Direct United States Cable Company	2	3,099.958
Direct West India Cable Company	2	1,265.300
Eastern Telegraph Company	139	39,749.360
Eastern Extension, Australasia and China Telegraph Company	34	24,802.240
Europe and Azores Telegraph Company	2	1,053.150
Eastern and South African Telegraph Company	14	9,068.052
Great Northern Telegraph Company	28	7,003.000
Halifax and Bermuda Cable Company	1	849.960
India Rubber, Gutta Percha and Telegraph Works Company	2	137.678
Indo-European Telegraph Company	3	22.000
Mexican Telegraph Company	3	1,529.000
Pacific and European Telegraph Company	....	....
River Plate Telegraph Company	3	138.000
South American Cable Company	2	2,065.224
Spanish National Submarine Telegraph Company	1	927.770
United States and Hayti Telegraph and Cable Company	1	1,389.000
West African Telegraph Company	6	1,470.867
West Coast of America Telegraph Company	7	1,975.100
West India and Panama Telegraph Company	24	4,639.000
[1] Western Telegraph Company	27	17,283.000
Western Union Telegraph Company	8	7,351.000
Total.	437	188,682.693

[1] Including London Platino-Brazilian and Montevidean and Brazilian Companies.

GENERAL SUMMARY.

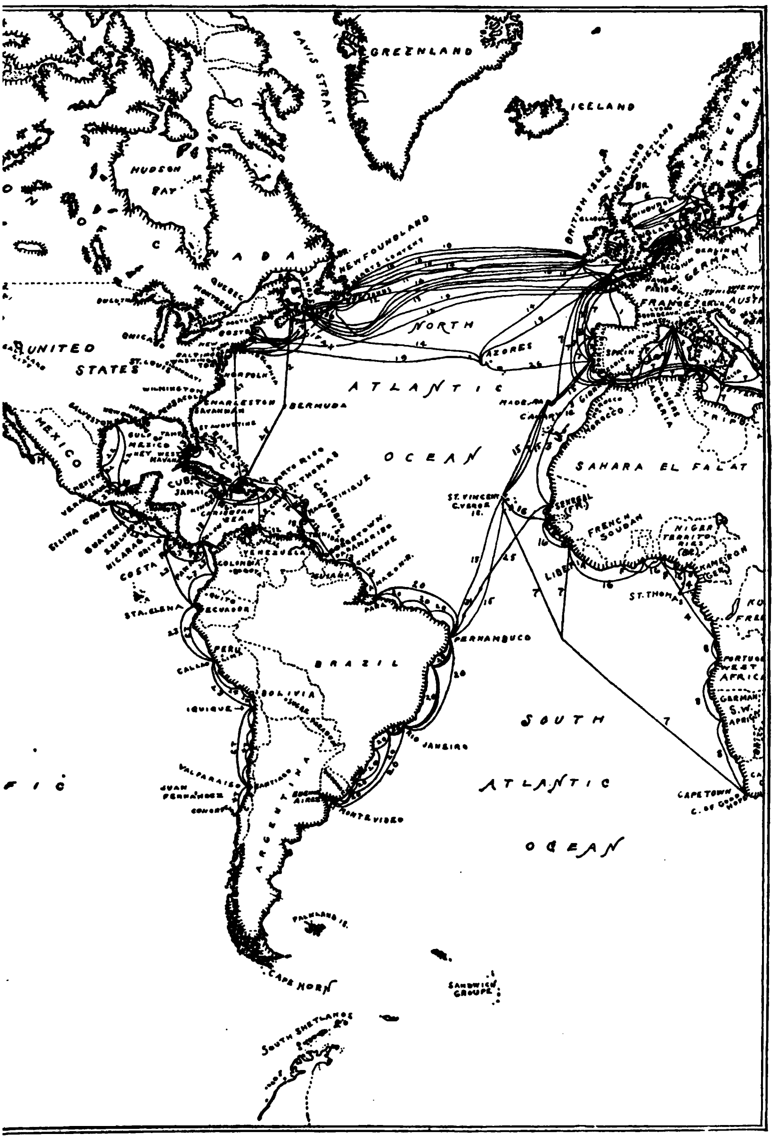
Ownership.	No. of Cables with One or More Cores.	Length of Cables in Nautical Miles.
Government Administrations	1,378	32,609.748
Private Companies	437	188,682.693
Total.	1.815	221,292.441

—*Electrical Trades Directory.*



SUBMARINE CABLES AND

(For explanation of letters and numbers



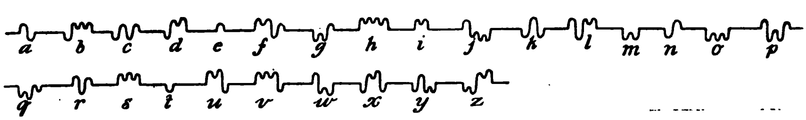
INTERNATIONAL DATE LINE.

shown on the above map, see page 199.]

MISCELLANEOUS INFORMATION PERTAINING TO SUBMARINE TELEGRAPH LINES, THEIR CONSTRUCTION AND OPERATION, 1902.

Length of first successful cable, miles	25
Length of first successful Atlantic cable, miles	2,134
Length of direct United States cable (Ballinskelligs Bay, Ireland, to Halifax, Nova Scotia), miles	2,564
Length of French cable (Brest, France, to Cape Cod, Massachusetts), miles	3,250
Distance from San Francisco to Hawaii, miles	2,089
Distance from Hawaii to Wake Island, miles	2,040
Distance from Wake Island to Guam, miles	1,290
Distance from Guam to Manila, miles	1,520
Distance from Manila to Asiatic Coast, miles	·630
Depth of water in which first successful cable was laid, feet	120
Depth of Atlantic cable lines, feet.	14,000
Greatest depth at which cable has been laid between Haiti and Windward Islands, feet	18,000
Greatest depth between San Francisco and Hawaii, feet	18,300
Greatest depth between Hawaii and Manila (estimated), feet	19,600
Capital of first Atlantic cable company	$1,750,000
Contract price of cable for first Atlantic line	$1,125,000
Contract price of cable for first successful Atlantic cable line	$3,000,000
Present cost per mile of cable (estimate by Bright)	$750
Cost of laying per mile, average	$375
Number of words per minute sent on first line	3
Number of words per minute on first successful Atlantic cable line at beginning	8
Number of words per minute on first successful Atlantic cable line after experimental stage	15
Present rate of speed (without duplex)	25
Present rate by automatic system (without duplex)	50
Increased use of wire by duplexing, per cent	90
Number of cables laid across the North Atlantic	16
Number now working	13
Average life of cable, years	25
Original rates for messages, first Atlantic lines (minimum 20 words or less)	$100
On first reduction (minimum, 20 words or less)	$50
Original word rate, without minimum	$1
Present word rate, without minimum	$0.25
Length of telegraph cables of the world, miles	193,000
Length of land lines of the world (1898) (estimate by Bright), miles	See page 185
Cost of cable lines of the world (estimate by Bright)	$250,000,000
Cost of land lines of the world (estimate by Bright)	$310,000,000
Total length of telegraph wires, land and cable (estimate by Bright), miles	2,300,000
Number of cable messages sent annually (estimate by Bright)	6,000,000
Per cent of world's lines built by governments	10
Per cent built by private enterprise	90
Time of message and answer, Washington to Santiago battlefield and return, minutes	1½
Time of message, Washington to London and reply in chess match of 1898, seconds	13½
Number of cables owned by nations	1,380
Length of cables owned by nations, miles	21,528
Number of cables owned by private companies	370
Length of cables owned by private companies, miles	171,679
Longest single line without intermediate landing, miles	3,250

THE CABLE ALPHABET.



The cut above shows the Morse Code as recorded by a syphon recorder. Syphon recorders are used for receiving cable messages. It will be observed that the spaces are represented by horizontal lines, dots by loops above the space lines, and dashes by loops below the space lines.

SUBMARINE CABLES AND INTERNATIONAL DATE LINE.

The International Date Line is an imaginary line drawn through the Pacific Ocean irregularly, but trending generally in a north and south direction. The islands of the Pacific Ocean are separated in such a way that all those which lie to the east of it carry the same date as the United States, while all those on the west of it use the same date as Japan and Australia. Our map on pages 196 and 197 shows this date line.

The submarine cable connections that are marked with letters represent the telegraph cables that are owned and operated by sovereign states. Those that are marked with numbers represent telegraph cables that are owned and operated by private companies. The explanation of the names of the countries that the letters represent and of the names of the companies that the numbers stand for is subjoined:

GOVERNMENTS.

A.	Austria.	G.	Germany.	Sw.	Sweden.
B.	Belgium.	Gr.	Greece.	T.	Turkey.
Br.	Great Britain.	I.	Italy.	U. S.	United States.
C.	China.	J.	Japan.	P.	Portugal.
C. C.	Cochin China.	M.	Mexico.	R.	Russia.
D.	Denmark.	N.	Netherlands.	S.	Spain.
F.	France.				

PRIVATE COMPANIES.

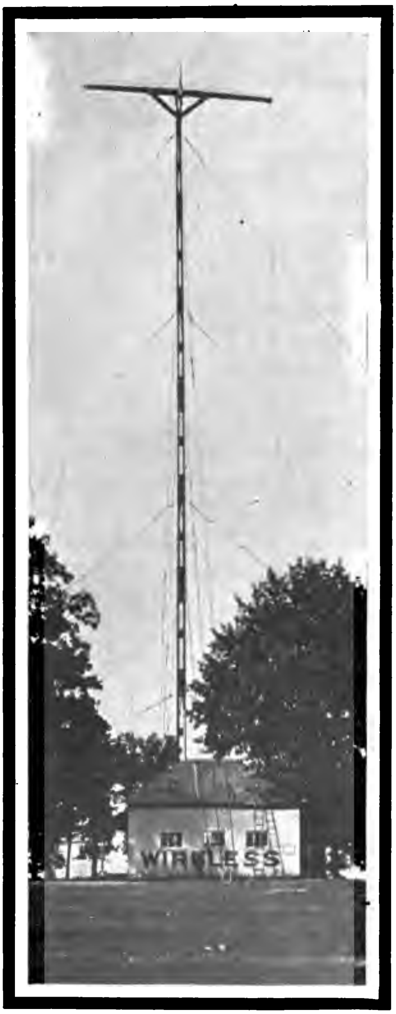
1. Direct Spanish Telegraph Company.
2. Halifax and Bermuda Cable Company.
3. Spanish National Submarine Telegraph Company.
4. West African Telegraph Company.
5. Black Sea Telegraph Company.
6. Great Northern Telegraph Company.
7. Eastern Telegraph Company.
8. Eastern and South African Telegraph Company.
9. Eastern Extension, Australasia, and China Telegraph Company.
10. Anglo-American Telegraph Company.
11. Direct United States Cable Company.
12. Compagnie Française des Câbles Télégraphiques.
13. Western Union Telegraph Company.
14. The Commercial Cable Company.
15. Brazilian Submarine Telegraph Company.
16. African Direct Telegraph Company.
17. Cuba Submarine Telegraph Company.
18. West India and Panama Telegraph Company.
19. Deutsche See-Telegraphen-Gesellschaft
20. Western and Brazil Telegraph Company.
21. River Plate Telegraph Company.
22. Mexican Telegraph Company.
23. Central and South American Telegraph Company.
24. West Coast of America Telegraph Company.
25. South American Cable Company.
26. Europe and Azores Telegraph Company.
27. United States and Hayti Telegraph and Cable Company.
28. Direct West India Cable Company.
29. The Pacific Commercial Cable Company.

WIRELESS TELEGRAPHY.

Wireless telegraphy is, in theory, closely allied to heliography, or signaling with flashes of light. The light used, however, is produced electrically and is invisible to the naked eye, owing to the fact that it is made up of very long waves, called Hertzian waves, which vibrate too slowly to affect the retina. The eye can only discern waves which make from 4,000 billions to 7,000 billions vibrations per minute. However, the Hertzian ray resembles light in that it can be reflected by a metallic plate and can be refracted by a prism of pitch, can be brought to a focus with a pitch lens, and may be polarized. Owing to the great length of the Hertzian waves, almost all substances are transparent to them. The Hertzian waves were discovered by Professor Heinrich Hertz, a young German philosopher, during his experiments with the spark discharge of Leyden jars and of the Ruhmkorff coil in 1886 and 1887.

He found that when a spark leaped the gap between the terminals, electric oscillations took place in these terminals which set up magnetic waves in the surrounding space, capable in turn of setting up similar oscillations in any adjacent conductor lying at an angle to them. The waves were detected by using a "resonator," which was merely a circle or a rectangle of copper wire formed with a gap in one side. When the induction coil was in operation and the resonator was held near the coil, a tiny stream of sparks would leap across the resonator gap. To better understand this phenomenon take as a crude example two vertical rods

in a pool of water and on each a float free to slide vertically on the rod. Now, if one of these floats be moved up and down upon its rod, it produces



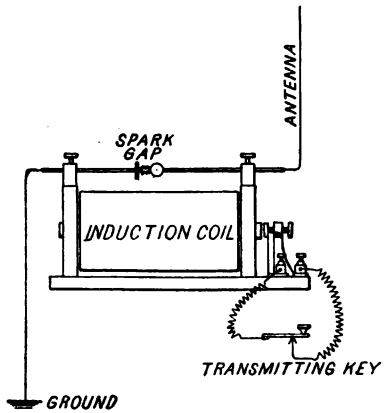
A TYPICAL WIRELESS TELEGRAPH STATION.

waves in the water just as the electric oscillation produces waves in the ether. These spread out in all directions and on reaching the other float cause it to oscillate up and down, just as the magnetic waves produce electric oscillations in the resonator.

Without going into a detailed history of the development of wireless telegraphy from Hertz's experiments, it may be stated that the essential difference between the apparatus used by Hertz in his experiments and the several systems now commonly in use lies in the receiver. The transmitter is practically the same. A vertical wire called the antenna is connected to one terminal of the coil, and the other terminal is connected with the earth, the purpose being to increase the electrical capacity of the terminal rods and produce larger waves. Instead of producing the oscillations by means of an induction coil, they are now ordinarily produced by a dynamo and a step-up transformer except for telegraphing over short distances. But even with these changes we would not be able to telegraph over any appreciable distance if dependent upon the Hertz resonator for receiving a message, for, owing to the fact that the waves spread out in all directions from the transmitting antenna, the receiving antenna is acted upon by a very small proportion of the power expended by the transmitter, and this proportion decreases very rapidly as the distance between the transmitter and the receiver increases. In order then to detect the rays at long distances, a very sensitive instrument called the "coherer" has been invented. The coherer in its usual form consists of a glass tube with two metal pistons fitted therein between which a quantity of nickel filings is placed. The latter forms an imperfect electrical contact between the pistons, and takes the place of the spark gap in the receiving antenna. When the oscillations are set up in the antenna by the Hertzian waves, due to their high pressure or voltage, they break through the imperfect contact of the coherer, causing the filings therein to cohere or string together and thus produce a much better electric path through the coherer. The action is microscopic and cannot be detected with the naked eye. However, the coherer, aside from being a part of the antenna circuit, is also made a part of a local battery circuit, which contains a telegraph receiver, and whenever the electric oscillations open a good path through the filings for the local circuit, the telegraph instrument will be energized by the local battery only. In order to break this path after the oscillations

have ceased, or, in other words, to cause the filings to decohere, they are constantly jarred apart by means of the "tapper," which is in reality an electric bell with the gong removed and the clapper striking the coherer tube instead. Carbon granules may be substituted for metallic filings, and in this case no tapper is necessary, the coherer being self-restoring.

In transmitting messages a telegraph key in the primary circuit of the induction coil is operated according to the usual Morse code, and this causes sparks to leap the spark gap at corresponding intervals. These signals will then be transmitted by the Hertzian waves to the receiving station, where they will be recorded by the telegraph

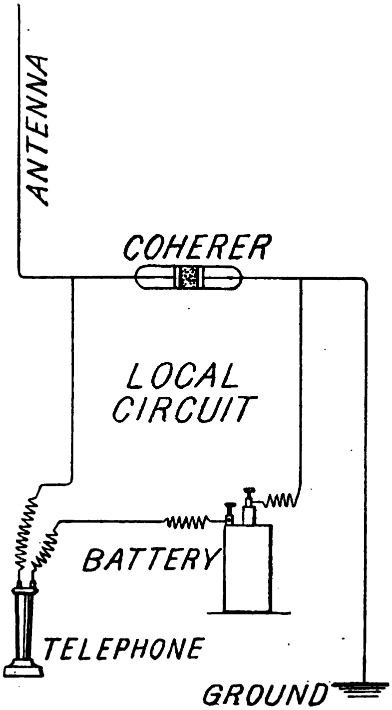


TRANSMITTER.

receiver. The coherer is not by any means the only wave detector in use. Every wireless telegraph company has one or more different types of detectors, but for the most part they are all based on the principle of the imperfect contact. Marconi's "magnetic detector" is a notable exception. The present efforts of inventors in the field of wireless telegraphy are directed mainly to the development of a system which will not allow one equipment to interfere with or suffer interference from any other equipment. This is essential in order to prevent unauthorized persons from intercepting and reading the messages. They aim to effect this result by synchronizing or tuning the transmitting and receiving stations so that they will give oscillations and respond to oscillations of a certain periodicity only. Up to the present time these efforts have met with only partial success.

PRINCIPAL SYSTEMS OF WIRELESS TELEGRAPHY.

The best known systems of wireless telegraphy in the United States are the Marconi, the De Forest and the Fessenden systems, and one or two sys-



RECEIVER.

tems used by the Government. In England, aside from the Marconi system, are the Lodge-Muirhead and the Orling-Armstrong systems. The Slaby-Arco and the Braun-Siemens-Halske systems are used in Germany. In France, Branley, Rochefort, Tissot and Captain Ferrie have made important developments, and in Russia Popoff early invented a system very similar to that of Marconi.

THE MARCONI SYSTEM.

The Marconi system, developed by Signor Guglielmo Marconi, a young

Italian inventor, is the pioneer system of Hertzian wave telegraphy. In 1896 Marconi accepted an invitation from the British Telegraph Department to make experiments with his system in England. In the spring of 1899 the first wireless message was transmitted across the English channel. On November 15, 1899, the first daily newspaper ever published on an Atlantic liner was issued on the steamer St. Paul, containing news transmitted from shore by wireless telegraphy. In 1900 the system was adopted by the British Admiralty and installed on their battleships and cruisers. On December 12, 1901, Marconi succeeded in sending the signal for the letter "S" across the Atlantic from Poldhu, Cornwall, to St. John's, Newfoundland. But his experiments were interrupted by a cable company which owned a monopoly of all telegraph communications with Newfoundland. In March, 1902, Marconi crossed the Atlantic on the "Philadelphia," which had been equipped with his instruments, and was able to receive intelligible messages at a distance of 1,551 miles from the Poldhu station. In October of the same year Marconi sailed from England to Nova Scotia, and received messages from his Poldhu station throughout the voyage. On January 18, 1903, the first wireless message from the United States to England was sent by President Roosevelt to King Edward. In March, 1903, the Marconi Company undertook to furnish the London "Times" with daily wireless despatches from the United States, but they were discontinued after a couple of despatches had been sent. The Italian Government, in 1903, voted $160,000 for the erection of a Marconi station in Italy to communicate with this country.

STATIONS EQUIPPED WITH MARCONI APPARATUS.

Country.	Location.	Operated by
Belgium	Nieuport	Belgian Government
Canada	Table Head, Cape Breton	Marconi W. T. Co. of Canada
China	Pekin	Italian Government
	Tientsin	" "
	Hongkong	British Government
Germany	Borkum Isle	North German Lloyd S. S. Co.
	Borkum Riff	" " " "
Great Britain and Ireland (List incomplete)	Caister	Marconi W. T. Co., Limited
	Chelmsford	" " "
	Fraserburgh	" " "
	Frinton	" " "
	Haven, Poole Harbor	" " "
	Holyhead	" " "
	Poldhu	" " "
	Withernsea	" " "
	Fastnet Rock	Lloyds
	Malin Head	"
	Inishtrahull	"
	Culver Cliff	British Government
	Dover	" "
	Plymouth	" "
	Portland	" "
	Portsmouth	" "
	Rane Head	" "
	Roches Point	" "
	Scilly Islands	" "
	Sheerness	" "
Holland	Amsterdam	Marconi W. T. Co., Limited
Italy (List incomplete)	Darignano	Italian Government
	Genoa	" "
	Gulf of Aranci	" "
	Maddalena	" "
	Monte Mario	" "
	Palmaria	" "
	Pisa	" "
	Punta di Bela	" "
	Rome	" "
	San Vito	" "
	Bari	Marconi W. T. Co., Limited
Montenegro	Antivari	Marconi W. T. Co., Limited
United States	Great Neck, Long Island	Private

On the preceding page is a list of stations equipped with Marconi apparatus and operated under arrangement with stations owned and controlled by Marconi Wireless Telegraph Company of America and affiliated Marconi companies.

There are also wireless telegraph stations equipped with Marconi apparatus and operated by the British Government at Bermuda, Gibraltar and Malta.

The following is a list of wireless telegraph offices on shore owned and controlled by Marconi Wireless Telegraph Company of America and affiliated Marconi companies:

Babylon........Long Island, New York, U. S. A.
Belle Isle.......Gulf of St. Lawrence, Canada.
Chateau Bay...Canadian Labrador.
Crookhaven.... County Cork, Ireland.
Fame Point.....Province Quebec, Canada.
Heath Point.....Province Quebec, Canada.
Liverpool.......Lancashire, England.
Lizard Point....Cornwall, England.
New York City. .Pier 14, North River, New York City, U. S. A.
Niton..........Isle of Wight, England.
North Foreland. Kent, England.
Rosslare........County Wexford, Ireland.
Sagaponack.....Long Island, New York, U. S. A.
Siasconset......Nantucket Island, Massachusetts, U. S. A.
South Wellfleet. .Cape Cod, Massachusetts, U. S. A.

The following points are in course of construction:

Canso..........Nova Scotia.
Cape Race......Newfoundland.
Point Amour.. .Canadian Labrador.
Sable Island....Canada.

The following is a list of Transatlantic liners equipped with Marconi apparatus:

Allan Line.—Bavarian, Parisian, Tunisian.

American Line.—New York, Philadelphia, St. Louis, St. Paul.

Atlantic Transport Line.—Minneapolis, Minnehaha, Minnetonka.

Compagnie Generale Transatlantique.—La Bretagne, La Champagne, La Lorraine, La Savoie, La Touraine.

Cunard Line.—Aurania, Campania, Carpathia, Etruria, Ivernia, Lucania, Pannonia, Saxonia, Umbria.

Hamburg-American Line.—Auguste Victoria, Blücher, Deutschland, Fürst Bismarck, Moltke.

Holland-American Line.*—Amsterdam, Maasdam, Noordam, Potsdam, Rhyndam, Rotterdam, Statendam.

Italian Royal Mail Line.—Lombardia, Sardegna.

North German Lloyd Line.—Grosser Kurfürst, Kaiser Wilhelm der Grosse, Kaiser Wilhelm II, Kaiserin Maria Theresia, Kronprinz Wilhelm.

Red Star Line.—Finland, Kroonland, Vaderland, Zeeland.

*In course of equipment.

All commissioned ships of British and Italian Royal Navies are equipped with the Marconi apparatus.

THE DE FOREST SYSTEM.

The American De Forest Wireless Telegraph Company has developed from the inventions of Dr. Lee de Forest, a young Yale graduate. His system differs from that of Marconi chiefly in the receiver. At first an instrument called the "anti-coherer," or "responder," was used in place of the coherer. The action of this instrument was just the reverse of the coherer, that is, a good path was normally provided for the local circuit, but this path was broken by the electric oscillations in the antenna. The anti-coherer was later replaced by another instrument, which acts electrolytically to a large extent. This instrument, like the coherer, normally offers a resistance to the current in the local circuit, but this resistance is broken down by the electric oscillations in the antenna. Another difference between the systems lies in the fact that the De Forest company uses a telephone receiver in the local circuit instead of the telegraph receiver for receiving the signals. Signals by the De Forest system can be transmitted at the rate of twenty-five to thirty words per minute. The De Forest Company has established a score of stations along the Atlantic coast, and several along the Great Lakes. Late in 1903 the De Forest Company entered into a contract with the London "Times" to furnish news of the Russo-Japanese war. The steamer "Haimun" was equipped with wireless telegraph apparatus, and rendered valuable service in reporting naval operations and engagements. These reports were sent by wireless telegraphy to Wei-hai-Wei and thence by cable to London. In July, 1904, the United States Government closed a contract with the De Forest Company for a series of stations in the West Indies and Panama. These, it is stated, are to form links in a chain of De Forest stations which will connect New England with Japan, China and the Philippines. The chain is to follow the Atlantic coast to Key West, and thence run via Porto Rico to Panama. From Panama it will follow the Pacific coast to Seattle, thence via the Aleutian Islands to Japan, Wei-hai-Wei, China and the Philippines, returning to San Francisco through Guam and Hawaii. Under the terms

of the contract, commercial messages are to be interchangeable between all stations equipped with the De Forest system, whether operated by the Government or the De Forest Company.

The following is a list of wireless telegraph stations, equipped with De Forest apparatus, and now complete and in operation for the transmission of wireless messages:

Station.	Location.	Operated by
Buffalo	New York	De Forest Company
Cape Hatteras	North Carolina	" " "
Chicago	Illinois (3 stations)	" " "
Cleveland	Ohio	" " "
Dallas	Texas	" " "
Fort Worth	Texas	" " "
Havana	Cuba	" " "
Highlands of Navesink	New Jersey	" " "
Key West	Florida	" " "
New York	New York City, 42 Broadway	" " "
Providence	Rhode Island	" " "
Quogue	Long Island, N. Y.	" " "
Louisiana Purchase Exposition Tower (and 9 other stations)	St. Louis, Mo.	" " "
Springfield	Illinois	" " "
Toronto	Canada	" " "
Washington	District of Columbia	" " "
Block Island	Rhode Island	Providence Journal Company
Point Judith	" "	" " "
Bocas del Toro	Panama	United Fruit Company
Port Limon	Costa Rica	" " "
Cape Nome	Alaska	Signal Corps, U. S. Army
St. Michael's	"	" " "
Four stations	Artillery Districts	" " "
Farralone Islands (4 stations)	Pacific Coast	U. S. Weather Bureau
Wei-hai-wei	China	London Times.

The following steamers are equipped with De Forest apparatus:

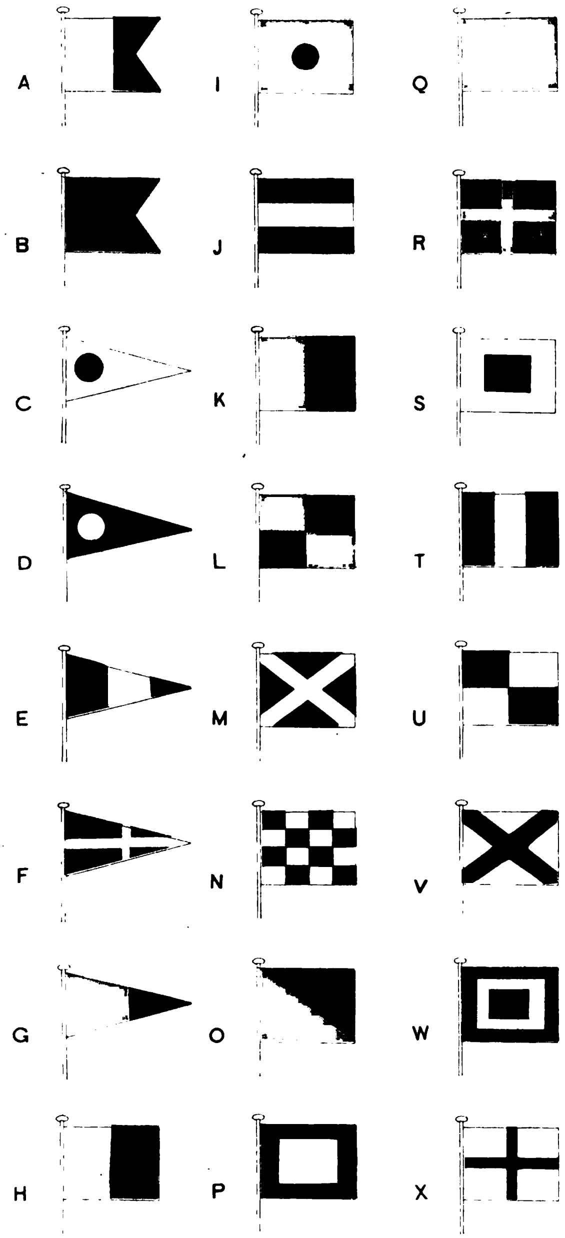
Steamer.	Location.	Operated by
Str. Wolvin	Great Lakes	U. S. Steel Corporation
" Haimun	China Sea	London Times
Tug Savage	North Atlantic ports	B. & O. Ry.

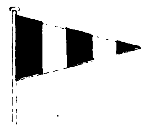
The following De Forest stations have been erected or are in course of erection:

Station.	Location.	Operated by
Atlantic City	New Jersey	De Forest Company
Baltimore	Maryland	" " "
Boston	Massachusetts	" " "
Cape Flattery	Washington	" " "
Cape May	New Jersey	" " "
Detroit	Michigan	" " "
Kansas City	Missouri	" " "
Lewes	Delaware	" " "
Mobile	Alabama	" " "
Newburgh	New York	" " "
New Haven	Connecticut	" " "
Port Huron	Michigan	" " "
Poughkeepsie	New York	" " "
Seattle	Washington	" " "
Sedalia	Missouri	" " "
Guantanamo	Cuba	U. S. Government
Panama	Panama	" "
Pensacola	Florida	" "
Porto Rico	West Coast	" "
Azores Islands (5 stations)		Eastern Telegraph and Cable Co.

Steamers.—Six vessels of the United States Navy.

FLAGS AND PENNANTS TO BE USED IN THE INTERNATIONAL CODE.

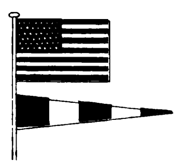




"CODE FLAG" AND "ANSWERING PENNANT."

When used as the "Code Flag" it is to be hoisted under the ensign.

When used as the "Answering Pennant" it is to be hoisted at the masthead or where best seen.



To open communication by the old Code, show the ensign with the pennant under it.

INTERNATIONAL WIRELESS TELEGRAPHY CONFERENCE.

On account of the rival systems in use in this country and the different countries of Europe, it was decided to hold an international conference, at which rules could be formulated to control them. The conference met at Berlin in August, 1903. The following rules were adopted, applying to the exchange of messages between vessels at sea and coast stations:

Any fixed station whose field of action extends to the sea is styled a coast station.

Coast stations are bound to receive and transmit telegrams originating from or intended for vessels at sea without any distinction of wireless telegraph system used by the latter.

Contracting parties shall publish any technical information likely to facilitate or expedite communication between coast stations and ships at sea.

The wireless station must, unless it should be absolutely impossible, accept in preference requests for help that may come from vessels.

The service of wireless telegraph stations must be organized as far as practicable so as not to interfere with the service of other stations.

The protocol was signed by the United States, Germany, Austria, Spain, France and Russia. Great Britain and Italy were unable to sign. The general feeling of the conference was decidedly against monopolization of the wireless telegraph business by any one company.

NEW INTERNATIONAL CODE OF SIGNALS.

The new International Code of Signals came into use on January 1, 1901, and its distinguishing sign will henceforward be the code pennant hoisted in the ordinary way.

Illustrations of the new signals are given in the plate, together with rules for signals of distress in the text.

It is not now necessary to tie the fly of the Code Pennant to the halyards, as was previously required when beginning to signal. When hoisted under the ensign, it denotes a signal taken from the International Code. When hoisted by itself at the masthead it is the Answering Pennant.

Communication may then be commenced, and any message following in this page, or found under the heading "Danger or Distress" in the International Code Signal Book, may be exchanged, strictly following the International Commercial Code and the instructions given above.

The International Code Signal described above, asking to open communication, should be shown in every case of distress by the shore station, for it may be that the vessel has the International Code, but, until seeing this signal, will not know that she can use it.

SIGNALS ADOPTED FROM AND TO BE FOUND IN INTERNATIONAL COMMERCIAL CODE SIGNAL BOOK OF 1899, REFERRED TO ABOVE.

N C	In distress; want immediate assistance.
D C	We are coming to your assistance.
E Y	Do not attempt to land in your own boats.
B I	Damaged rudder; can not steer.
B J	Engines broken down; I am disabled.
J D	You are standing into danger.
F Z	Heavy weather coming; look sharp.
F R	Bar is impassable.
I E D	Cast off.
R I F	Make fast—to—
W F Q	Slack away.
K T	Shift your berth. Your berth is not safe.
K P	Hold on until high water.
K H	Remain by the ship.
A B	Abandon the vessel as fast as possible.
K D	Landing is impossible.
K F	Look out for rocket line (*or*, line).
K A	Endeavor to send a line by boat (cask, kite, raft, etc.).
C X	No assistance can be rendered; do the best you can for yourselves.
K G	Lookout will be kept on the beach all night.

INTERNATIONAL COMMERCIAL CODE SIGNALS—*Continued.*

K E	Lights, *or* Fires will be kept at the best place for coming on shore.
K C	Keep a light burning.
A D	Do not abandon the vessel until the tide has ebbed.
N M	I am on fire.
N O	I am sinking (*or*, on fire); send all available boats to save passengers and crew.
Y F	Want assistance; mutiny.
Y L	Want immediate medical assistance.
Y G	Want a boat immediately (*if more than one, number to follow*).
Y P	Want a tug (*if more than one, number to follow*).
A G	I must abandon the vessel.
P T	Want a pilot.
V G	What is name of ship or Signal Station in sight?
D U	Repeat ship's name; your flags were not made out.
W C X	Signal not understood, though the flags are distinguished.
N C X	I can not make out the flags (*or*, signals).
C	Assent—Yes.
D	Negative—No.

DISTRESS SIGNALS.

(Article 31 of International Rules.)

When a vessel is in distress and requires assistance from other vessels or from the shore the following shall be the signals to be used or displayed by her, either together or separately, namely:

In the daytime—

(1) A gun or other explosive signal fired at intervals of about a minute

(2) The International Code signal of distress indicated by N C.

(3) The distance signal, consisting of a square flag, having either above or below it a ball or anything resembling a ball.

(4) The distant signal, consisting of a cone, point upward, having either above it or below it a ball or anything resembling a ball.

(5) A continuous sounding with any fog-signal apparatus.

At night—

(1) A gun or other explosive signal fired at intervals of about a minute.

(2) Flames on the vessel (as from a burning tar barrel, oil barrel, and so forth).

(3) Rockets or shells throwing stars of any color or description, fired one at a time, at short intervals.

(4) A continuous sounding with any fog-signal apparatus.

LIST OF WEATHER BUREAU STATIONS ON THE UNITED STATES SEACOAST TELEGRAPHIC LINES.

Atlantic Coast.
- Nantucket, Massachusetts.
- Narragansett Pier, Rhode Island.
- Block Island, Rhode Island.
- Norfolk, Virginia.
- Cape Henry, Virginia.
- Currituck Inlet, North Carolina.
- Kitty Hawk, North Carolina.
- Hatteras, North Carolina.
- Sand Key, Florida.

Pacific Coast.
- Tatoosh Island, Washington.
- Neah Bay, Washington.
- East Clallam, Washington.
- Twin Rivers, Washington.
- Port Crescent, Washington.
- North Head, Washington.
- Point Reyes Light, California.
- San Francisco, California.
- Southeast Farallone, California.

Lake Huron.
- Thunder Bay Island, Michigan.
- Middle Island, Michigan.
- Alpena, Michigan.

Of the above stations the following, and also Jupiter, Florida, are supplied with International Code Signals, and communication can be had therewith for the purpose of obtaining information concerning the approach of storms, weather conditions in general, and for the purpose of sending telegrams to points on commercial lines.

- Nantucket, Massachusetts.
- Block Island, Rhode Island.
- Cape Henry, Virginia.
- Kitty Hawk, North Carolina.
- Sand Key, Florida.
- Tatoosh Island, Washington.
- Hatteras, North Carolina.
- Neah Bay, Washington.
- Point Reyes Light, California.
- Southeast Farallone, California.

Any message signaled by the International Code, as adopted or used by England, France, America, Denmark, Holland, Sweden, and Norway, Russia, Greece, Italy, Germany, Austria, Spain, Portugal, and Brazil, received at these telegraphic signal stations, will be transmitted and delivered to the address on payment at the station of the telegraphic charge. All messages received from or addressed to the War, Navy, Treasury, State, Interior, or other official department at Washington, are telegraphed without charge over the Weather Bureau lines.

SPECIAL DISTANT SIGNALS.

Made by a single hoist followed by the STOP signal. Arranged numerically for reading off a signal.

THESE SIGNALS MAY BE MADE BY THE SEMAPHORE, BY CONES, BALLS AND DRUMS, OR BY SQUARE FLAGS, BALLS, PENNANTS AND WHEFTS.

Signal.	Meaning.
2	"Preparative," "Answering," *or*, "Stop," after each complete signal.
1 2	Aground; want immediate assistance.
2 1	Fire, *or*, Leak; want immediate assistance.
2 2	Annul the whole signal.
2 3	You are running into danger, *or*, Your course is dangerous.
2 4	Want water immediately.
3 2	Short of provisions; starving.
4 2	Annul the last hoist; I will repeat it.
1 1 2	I am on fire.
1 2 1	I am aground.

Signal.	Meaning.
1 2 2	Yes, *or*. Affirmative.
1 2 3	No, *or*, Negative.
1 2 4	Send lifeboat.
1 3 2	Do not abandon the vessel.
1 4 2	Do not abandon the vessel until the tide has ebbed.
2 1 1	Assistance is coming.
2 1 2	Landing is impossible.
2 1 3	Bar, *or*, Entrance is dangerous.
2 1 4	Ship disabled; will you assist me into port?
2 2 1	Want a pilot.
2 2 3	Want a tug; can I obtain one?
2 2 4	Asks the name of ship (*or*, signal station) in sight, *or*, Show your distinguishing signal.

Signal.	Meaning.
2 3 1	Show your ensign.
2 3 2	Have you any dispatches (message, orders, *or*, telegrams) for me?
2 3 3	Stop, Bring-to, *or*, Come nearer; I have something important to communicate.
2 3 4	Repeat signal, or hoist it in a more conspicuous position.
2 4 1	Can not distinguish your flags; come nearer, or make Distant Signals.
2 4 2	Weigh, Cut, *or*, Slip; wait for nothing; get an offing.
2 4 3	Cyclone, Hurricane, *or*, Typhoon expected.
3 1 2	Is war declared, *or*, Has war commenced?
3 2 1	War is declared, *or*, War has commenced.
3 2 2	Beware of torpedoes; channel is mined.
3 2 3	Beware of torpedo boats.
3 2 4	Enemy is in sight.

3 3 2 Enemy is closing with you, *or*, You are closing with the enemy.

3 4 2 Keep a good look-out, as it is reported that enemy's men-of-war are going about disguised as merchantmen.

4 1 2 Proceed on your voyage.

The information relative to the International Code is taken from the thirty-fifth annual list of the merchant vessels of the United States and is published by the Bureau of Navigation, Department of Commerce and Labor.

THE FOLLOWING DISTANT SIGNALS MADE WITH FLAG AND BALL, OR PENNANT AND BALL, HAVE THE SPECIAL SIGNIFICATION INDICATED BENEATH THEM.

			
You are running into danger.	Fire, *or*, Leak; want immediate assistance.	Short of provisions. Starving.	Aground; want immediate assistance.

SEMAPHORES.

There are many semaphores established on the French, Italian, Portuguese, and some on the Spanish and Austrian coasts, where only the international Code of Signals is now used. Where practicable these semaphores have means of communicating by telegraph with each other and with the chief metropolitan lines and foreign stations.

Passing ships are able to exchange communication with the semaphores, and when required their messages are forwarded to their destination according to the fixed tariff. On the coasts of Great Britain there are signal stations which offer the same facilities to passing vessels.

BOAT SIGNALS.

The Symbols for Boat Signals are—

1. Two *square* flags, or handkerchiefs, or pieces of cloth.
2. Two long strips of cloth, or parts of a plank, or pieces of wood longer than broad.
3. Two balls or hats, or round bundles, or buckets.

With these any of the Distance Signals can be made—holding the Symbol at arm's length; and the Signal is to be *made from right to left* and *read from left to right*, thus:

Equivalent to Ball above Pennant, or, "You are running into danger."

In making Boat Signals it is important to use only the proper means to attract attention, and to avoid those that may occasion confusion or misinterpretation.

CYCLONES.

[Pilot Chart, Hydrographic Office.]

"RULE 1.—*If the squalls freshen without any shift of wind*, you are on or near the storm track: heave to on the starboard tack and watch for some indications of a shift, observing the low clouds particularly; if the barometer fall decidedly (say half an inch) without any shift, and if wind and sea permit, run off with the wind on the starboard quarter and keep your compass course.

"RULE 2.—*If the wind shift to the right*, you are to the right of the storm track. put the ship on the starboard tack and make as much headway as possible until obliged to lie-to (starboard tack).

"RULE 3.—*If the wind shift to the left*, you are to the left of the storm track: bring the wind on the starboard quarter and keep your compass course· if obliged to lie-to, do so on the port tack.

"GENERAL RULES, GOOD FOR ALL NORTHERN HEMISPHERE STORMS.—In scudding always keep the wind well on the starboard quarter, in order to run out of the storm. Always lie-to on the coming-up tack. Use oil to prevent heavy seas from breaking on board."

LIFE-SAVING SIGNALS.

The following signals recommended by the late International Marine Conference for adoption by all institutions for saving life from wrecked vessels, have been adopted by the Life-saving Service of the United States.

1. Upon the discovery of a wreck by night, the life-saving force will burn a red pyrotechnic light or a red rocket to signify, "You are seen; assistance will be given as soon as possible."
2. A red flag waved on shore by day, or a red light, red rocket, or red Roman candle displayed by night, will signify, "Haul away."
3. A white flag waved on shore by day, or a

white light slowly swung back and forth, or a white rocket or white Roman candle fired by night, will signify, "Slack away."

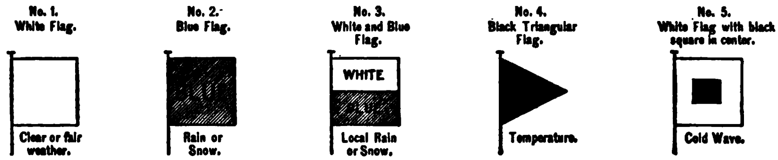
4. Two flags, a white and a red, waved at the same time on shore by day, or two lights, a white and a red, slowly swung at the same time, or a blue pyrotechnic light burned by night, will signify, "Do not attempt to land in your own boats; it is impossible."

5. A man on shore beckoning by day, or two torches burning near together by night, will signify, "This is the best place to land."

THE WEATHER BUREAU.

The Weather Bureau furnishes, when practicable, for the benefit of all interests dependent upon weather conditions, the "Forecasts" which are prepared daily at the Central Office in Washington, D. C., and certain designated stations. These forecasts are telegraphed to stations of the Weather Bureau, railway officials, postmasters and many others, to be communicated to the public by means of flags or steam whistles. The flags adopted for this purpose are five in number, and of the forms and colors indicated below:

EXPLANATION OF WEATHER FLAGS.



When number 4 is placed above number 1, 2 or 3 it indicates warmer; when below, colder; when not displayed, the temperature is expected to remain about stationary. During the late spring and early fall the cold-wave flag is also used to indicate anticipated frosts.

EXPLANATION OF WHISTLE SIGNALS.

A warning blast of from fifteen to twenty seconds duration is sounded to attract attention. After this warning the longer blasts (of from four to six seconds duration) refer to weather, and shorter blasts (of from one to three seconds duration) refer to temperature; those for weather are sounded first.

Blasts.	*Indicate.*
One long	Fair weather.
Two long	Rain or snow.
Three long	Local rain or snow.
One short	Lower temperature.
Two short	Higher temperature.
Three short	Cold wave.

By repeating each combination a few times, with intervals of ten seconds, liability to error in reading the signals may be avoided.

As far as practicable the forecast messages will be telegraphed at the expense of the Weather Bureau; but if this is impracticable, they will be furnished at the regular commercial rates and sent "collect." In no case will the forecasts be sent to a second address in any place except at the expense of the applicant.

Persons desiring to display the flags or sound the whistle signals for the benefit of the public should communicate with the Weather Bureau officials in charge of the climate and crop service of their respective States, the central stations of which are as follows:

Montgomery, Ala.; Phœnix, Ariz.; Little Rock, Ark.; San Francisco, Cal.; Denver, Colo.; Jacksonville, Fla.; Atlanta, Ga.; Boise, Idaho; Springfield, Ill.; Indianapolis, Ind.; Des Moines, Iowa; Topeka, Kan.; Louisville, Ky.; New Orleans, La.; Baltimore, Md. (for Delaware and Maryland); Boston, Mass. (for New England); Lansing, Mich.; Minneapolis, Minn.; Vicksburg, Miss.; Columbia, Mo.; Helena, Mont.; Lincoln, Nebr.; Carson City, Nev.; New Brunswick, N. J.; Santa Fe, N. Mex.; Ithaca, N. Y.; Raleigh, N. C.; Bismarck, N. Dak.; Columbus, Ohio; Oklahoma, Okla. (for Oklahoma and Indian Territories); Portland, Oreg.; Philadelphia, Pa.; Columbia, S. C.; Huron, S. Dak.; Nashville, Tenn.; Galveston, Tex.; Salt Lake City, Utah; Richmond, Va.; Seattle, Wash.; Parkersburg, W. Va.; Milwaukee, Wis.; Cheyenne, Wyo.

WILLIS L. MOORE,
Chief U. S. Weather Bureau.

CHAPTER IX.

PATENTS, TRADE MARKS, COPYRIGHTS.

PATENTS IN RELATION TO MANUFACTURES.

The value of our patent system is eloquently outlined by Senator Platt, of Connecticut. In speaking on a bill for the reorganization of the Patent Office, he said:

"To my mind, the passage of the act of 1836 creating the Patent Office marks the most important epoch in the history of our development—I think the most important event in the history of our Government from the Constitution until the Civil War. The establishment of the Patent Office marked the commencement of that marvelous development of the resources of the country which is the admiration and wonder of the world, a development which challenges all history for a parallel; and it is not too much to say that this unexampled progress has been not only dependent upon, but has been coincident with, the growth and development of the patent system of this country. Words fail in attempting to portray the advancement of this country for the last fifty years. We have had fifty years of progress, fifty years of inventions applied to the every-day wants of life, fifty years of patent encouragement, and fifty years of a development in wealth, resources, grandeur, culture, power which is little short of miraculous. Population, production, business, wealth, comfort, culture, power, grandeur, these have all kept step with the expansion of the inventive genius of the country; and this progress has been made possible only by the inventions of its citizens. All history confirms us in the conclusion that it is the development by the mechanical arts of the industries of a country which brings to it greatness and power and glory. No purely agricultural, pastoral people ever achieved any high standing among the nations of the earth. It is only when the brain evolves and the cunning hand fashions labor-saving machines that a nation begins to throb with new energy and life and expands with a new growth. It is only when thought wrings from nature her untold secret treasures that solid wealth and strength are accumulated by a people."

When the Japanese Government was considering the establishment of a patent system, they sent a commissioner to the United States and he spent several months in Washington, every facility being given him by the Commissioner of Patents. One of the examiners said: "I would like to know why it is that the people of Japan desire to have a patent system."

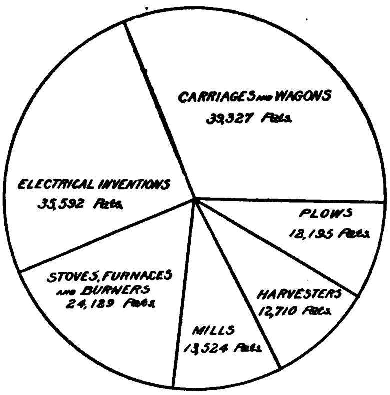
"I will tell you," said Mr. Takahashi. "You know it is only since Commodore Perry, in 1854, opened the ports of Japan to foreign commerce that the Japanese have been trying to become a great nation, like other nations of the earth, and we have looked about us to see what nations are the greatest, so that we could be like them; and we said, 'There is the United States, not much more than a hundred years old, and America was not discovered by Columbus yet four hundred years ago'; and we said, 'What is it that makes the United States such a great nation?' And we investigated, and we found it was patents, and we will have patents."

The examiner, in reporting this interview, added: "Not in all history is there an instance of such unbiased testimony to the value and worth of the patent system as practiced in the United States."

The demonstration thus given the commercial world during the last half century of the effect of beneficent patent laws has led to their modification in all the chief industrial countries, and the salient feature of our system—a preliminary examination as to novelty and patentability prior to the grant of a patent—has in late years been incorporated into the patent systems of many foreign countries, as, for instance, Austria, Canada, Den-

mark, Germany, Japan, Norway, Russia, Sweden, and Switzerland.

The discoverer of new products of value in the arts and the inventor of new processes, or improved machines, adds to public wealth, and his right to the product of his brain is now recognized by the laws of all civilized nations. The word "patent" had its origin in royal grants to favored subjects of monopolies in trade or manufacture; but now the word is used in a restricted sense to cover improvements in inventions. A few patents for inventions were granted by the provincial governments of the American colonies and by the legislatures of the States, prior to the adoption of the



PRINCIPAL FIELDS OF INVENTIVE ENDEAVOR.

Federal Constitution. On the 5th of September, 1787, it was proposed to incorporate in a constitution a patent and copyright clause. The germinating principle of this clause of the Constitution has vitalized the nation, expanded its powers beyond the wildest dreams of its fathers, and from it more than from any other cause, has grown the magnificent manufacturing and industrial development which we to-day present to the world.

In the early days the granting of a patent was quite an event in the history of the State Department, where the clerical part of the work was then performed. It would be interesting to see Thomas Jefferson, the Secretary of War, and the Attorney-General, critically examining the application and scrutinizing each point carefully and rigorously. The first year the majority of the applications failed to pass the ordeal, and only three patents were granted. In those days every step in the issuing of a patent was taken with great care and caution, Mr. Jefferson always seeking to impress upon the minds of his officers and the public that the granting of a patent was a matter of no ordinary importance. Prior to 1836 there was no critical examination of the state of the art preliminary to the allowance of a patent application. Since the act of 1836 there have been various enactments modifying and improving the law in matters of detail. In 1861 the term for a patent was increased from fourteen to seventeen years, and in 1870 the patent law was revised, consolidated and amended; but in its salient features the patent system of today is that of the law of 1836. The subject of patents is admirably treated by Mr. Story B. Ladd, of the Census Office, and we are indebted to Bulletin No. 242 for most interesting matter herewith presented.

The growth of the number of patents granted in the United States to citizens of foreign countries, is a striking feature, and shows the high esteem in which this country is held by the world at large as a field for the exploitation of invention. The per cent. of patents to foreign inventors has more than doubled during each period of twenty years since 1860.

The majority of these foreign patentees are citizens of the great manufacturing countries; four-fifths of them are from England, France, Germany, and Canada; the number from the latter country being largely augmented by reason of her proximity to the United States. The patents to foreign inventors, 1890-1900, were distributed as follows:

Country.	Number of Patents.	Per Cent.
Canada.	3,135	14.0
England.	7,436	32.0
France.	2,163	9.0
Germany.	5,788	25.0
All other countries.	4,561	20.0
Total to citizens of foreign countries.	23,083	100.0

This marked growth in the number of patents to aliens is explained by the very liberal features of our patent system. Foreigners stand here on an equal footing with citizens of this country, and they are neither sub-

jected to restrictions in the matter of annuities or taxes payable after the grant of a patent, nor required to work an invention in this country to maintain it in force, as is the case in most foreign countries.

Moreover, the thorough examination made by our Patent Office as to the novelty of an invention prior to the allowance of an application for a patent—an examination that includes not only the patents and literature of our own country bearing on the art or industry to which the invention relates, but the patents of all patent-granting countries and the technical literature of the world—and the care exercised in criticising the framing of the claims have come to be recognized as of great value in the case of inventions of merit, and hence the majority of foreign inventors patenting in this country take advantage of this feature of our patent system, and secure the action of the Patent Office on an application for a patent before perfecting their patents in their own and other foreign countries, taking due precaution to have their patents in the different countries so issued as to secure the maximum term in each, so far as possible. This practice holds now in the case of probably nine-tenths of the alien inventions patented in this country.

The working of an invention has never been required under our patent laws, though in most foreign countries, with the exception of Great Britain, an invention must be put into commercial use in the country within a specified period or the patent may be declared void. In the case of patents for fine chemicals and like products, which require a high order of technical knowledge and ability for their inception, and skilled workmen for their manufacture, the effect of this requirement, that the industry must be established within the country, has been most salutary in building up chemical industries within the home country, to some extent at the expense of other countries where the working of a patent is not obligatory. This shows most strongly in the case of carbon dyes and in the patents for chemicals of the class known as carbon compounds, which includes numerous pharmaceutical and medicinal compounds of recent origin, aldehydes, alcohols, phenols, ethers, etc., and many synthetic compounds, as vanillin, artificial musk, etc.

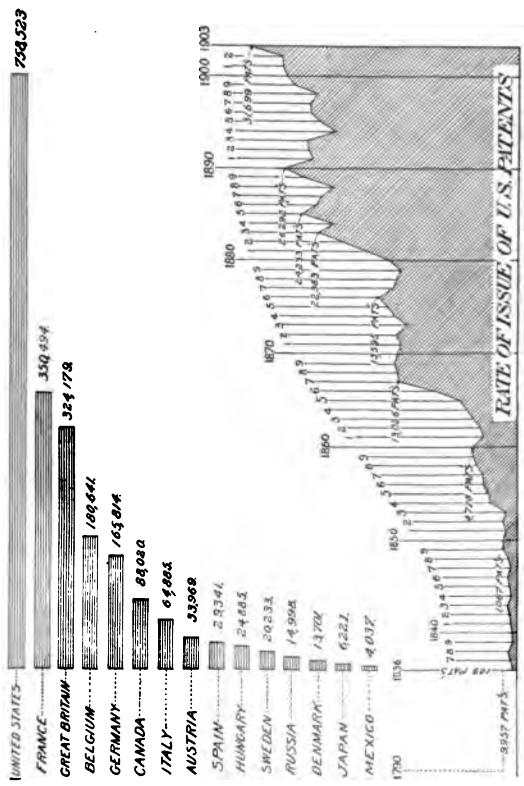
There are many extensive industries which are entirely the creation of patents, and can be readily differentiated from the great mass of manufactures; for example, certain industries based upon chemical inventions and discoveries, as oleomargarine, which now employs $3,023,646 of capital, and supplies products to the value of $12,499,812; glucose, which uses $41,011,345 of capital, and gives products to the value of $21,693,656; wood pulp, which, starting with the ground-wood pulp patent of Voulter, in 1858, and following with the soda fiber and sulphite fiber processes, is now the chief material employed in paper manufacture, with products aggregating $18,497,701; high explosives, which, starting with the nitroglycerin patent of Nobel, in 1865, now includes dynamite, the pyroxylin explosives, and smokeless powder, with products aggregating $11,233,396; while the electrical industries, which now touch all fields of industrial activity, power and transportation, lighting and heating, electrochemical processes, telegraphy and telephony, employ directly and indirectly capital extending into the billions, and are the creation of patents. The rubber industry was insignificant prior to the discovery by Charles Goodyear of the process of vulcanization, while now the products in the shape of rubber and elastic goods and rubber boots and shoes amount to $93,716,849. Bicycles and tricycles employ $29,783,659 of capital. with products valued at $31,915,908. Manufactured ice employs $38,204,054 of capital, with a return in products of $13,874,513.

Phonographs and graphophones, starting in 1877, now show the use of $3,348,282 of capital, and products to the value of $2,246,274. Photography, including the manufacture of materials and apparatus as well as the practice of the art—all the outcome of invention—is now represented by 7,706 establishments, with a combined capital of $18,711 339, and products to the value of $31,038,107. The manufacture of sewing machines employs $18,739,450 of capital, and supplies products to the value of $18,314,490. The manufacture of typewriters and supplies, within three decades, has become an industry that employs $8,400,431 of capital, and gives products to the value of $6,932,029. These are but examples of what may be considered as patent-created industries.

If we attempt to enumerate the industries which, existing prior to the

period of patent growth, have been revolutionized by inventions, a catalogue of all of the old industries is virtually required. The returns for the manufacture of agricultural implements for the present census show 715 establishments, with a capital of $157,707,951, giving employment to 46,852 wage-earners, who re- a patented improvement which has produced a new or better article, or cheapened the cost of manufacture.

The great iron and steel industry as it exists to-day is the product of countless inventions which permeate every branch thereof, and include many revolutionizing inventions, as, for example, the Bessemer process.



Copyright, 1904, by Munn & Co.

TOTAL NUMBER OF PATENTS TO DECEMBER 31, 1903.
(Foreign Patents for 1903 Estimated).

ceive $2,450,880 in wages, and manufactured products to the value of $101,207,428; and, in the entire range of agricultural implements and machines now manufactured every one, from hoe or spade to combined harvester and thrasher, has been, either in the implement or machine itself, or in the process of manufacture, the subject of The blast furnaces, rolling mills and forges and bloomeries, reported at the present census comprise 668 establishments, with a capital of $573,391,663, employing 222,490 wage-earners, with $120,820,276 paid in wages, and supplying products to the value of $803,968,273. A prohibition of the use of the patented inventions of the last half

century would stop every one of these establishments.

The same may likewise be said of the textile industry, the manufactures of leather, of lumber, chemicals, etc., and the railway system in its entirety, from the rail to the top of the smoke-stack, and from the pilot to the rear train light or signal, is an aggregation of American inventions.

Without attempting to touch upon the industries which have been revolutionized or expanded by patents, the summaries which follow aim to show the growth of patents which have generally sprung from industries.

The closing decades of the nineteenth century have witnessed the most extraordinary development of manufactures and commerce known in our history. Industrial demand and invention go hand in hand. They act and react, being interdependent. Any change in industrial conditions creating a new demand is at once met by the invention of the means for supplying it, and through new inventions new industrial demands are every year being created. Thus through the process of evolution the industrial field is steadily expanding, and a study of the inventions for any decade will point out the lines of industrial growth for the succeeding decade.

The following figures give an idea of the development of American inventions during the past fifty-four years:

NUMBER OF PATENTS FOR INVENTIONS ISSUED DURING EACH CALENDAR YEAR, AND NUMBER OF LIVE PATENTS AT THE BEGINNING OF EACH CALENDAR YEAR.

Year.	Number of Patents Issued During the Year.	Number of Live Patents.	Year.	Number of Patents Issued During the Year.	Number of Live Patents.
1850	884	6,987	1877	12,920	155,200
1851	757	7,769	1878	12,345	168,011
1852	890	8,099	1879	12,133	177,737
1853	846	8,474	1880	12 926	186,408
1854	1,759	8,928	1881	15,548	195,325
1855	1,892	10,251	1882	18,135	206,043
1856	2,315	11,673	1883	21,196	218,041
1857	2,686	13,518	1884	19,147	230,360
1858	3,467	15,714	1885	23,331	237,204
1859	4,165	18,714	1886	21,797	247,991
1860	4,363	22,435	1887	20,429	256,831
1861	3,040	26,252	1888	19,585	265,103
1862	3,221	28,795	1889	23,360	273,001
1863	3,781	31,428	1890	25,322	284,161
1864	4,638	34,244	1891	22,328	297,867
1865	6,099	38,034	1892	22,661	307,965
1866	8,874	43,415	1893	22,768	317,335
1867	12,301	51,433	1894	19,875	325,931
1868	12,544	62,929	1895	20,883	332,886
1869	12,957	73,824	1896	21,867	341,424
1870	12,157	85,005	1897	22,098	351,158
1871	11,687	94,910	1898	20,404	360,330
1872	12,200	104,022	1899	23,296	365,186
1873	11,616	112,937	1900	24,660	370,347
1874	12,230	120,551	1901	25,558	373,811
1875	13,291	128,547	1902	27,136	380,222
1876	14,172	141,157	1903	31,046	393,276

The theory of the patent law is simple. The country is enriched by inventions and offers for them a small premium; this premium is a seventeen years' monopoly of their fruit—no more, no less. Having purchased the invention for this insignificant price, the purchase is consummated by the publication in the patent records of the details of the invention so that he who runs may read. The whole thing is a strictly business transaction, and

this character is emphasized by the fact that the inventor is required to pay for the clerical and expert labor required to put his invention into shape for issuing. His patent fees are designed to cover this expense, and do so, with a considerable margin to spare. Thus the people of the United States are perpetually being enriched by the work of inventors, at absolutely no cost to themselves.

The inventor does not work for love nor for glory alone, but in the hopes of a return for his labor. Glory, and love of his species, are elements actuating his work, and in many cases he invents because he cannot help himself, because his genius is a hard task master and keeps him at work. But none the less, the great incitement to invention is the hope of obtaining a valuable patent, and without this inducement inventions would be few and far between, and America would, without the patent system, be far in arrears of the rest of the world, instead of leading it, as it does to-day. The few pregnant sentences of the patent statutes, sentences the force of whose every word has been laboriously adjudicated by our highest tribunal, the Supreme Court of the United States, are responsible for America's most characteristic element of prosperity, the work of her inventors, to whom belongs the credit.

DISTINGUISHED AMERICAN INVENTORS.

Benjamin Franklin; b. Boston, 1706; d. 1790; at 12, printer's apprentice, fond of useful reading; 27 to 40, teaches himself Latin, etc., makes various useful improvements; at 40, studies electricity; 1752, brings electricity from clouds by kite, and invents the lightning rod.

Eli Whitney, inventor of the cotton-gin; b. Westborough, Mass., 1765; d. 1825; went to Georgia 1792 as teacher; 1793, invents the cotton-gin, prior to which a full day's work of one person was to clean by hand one pound of cotton; one machine performs the labor of five thousand persons; 1800, founds Whitneyville, makes firearms, by the interchangeable system for the parts.

Robert Fulton; b. Little Britain, Pa., 1765; d. 1825; artist painter; invents steamboat 1793; invents submarine torpedoes 1797 to 1801; builds steamboat in France 1803; launches passenger boat Clermont at N. Y. 1807, and steams to Albany; 1812, builds steam ferryboats; 1814, builds first steam war vessel.

Jethro Wood, inventor of the modern cast-iron plough; b. White Creek, N. Y., 1774; d. 1834; patented the plough 1814; previously the plough was a stick of wood plated with iron; lawsuits against infringers consumed his means; Secretary Seward said: "No man has benefited the country pecuniarily more than Jethro Wood, and no man has been as inadequately rewarded."

Thomas Blanchard; b. 1788, Sutton, Mass.; d. 1864; invented tack machine 1806; builds successful steam carriage 1825; builds the stern-wheel boat for shallow waters, now in common use on Western rivers; 1843, patents the lathe for turning irregular forms, now in common use all over the world for turning lasts, spokes, axe-handles, gun-stocks, hat-blocks, tackle-blocks, etc.

Ross Winans, of Baltimore; b. 1798, N. J.; author of many inventions relating to railways; first patent, 1828; he designed and patented the pivoted, double truck, long passenger cars now in common use. His genius also assisted the development of railways in Russia.

Cyrus H. McCormick, inventor of harvesting machines; b. Walnut Grove, Va., 1809; in 1851 he exhibited his invention at the World's Fair, London, with practical success. The mowing of one acre was one man's day's work; a boy with a mowing machine now cuts 10 acres a day. Mr. McCormick's patents made him a millionaire.

Charles Goodyear, inventor and patentee of the simple mixture of rubber and sulphur, the basis of the present great rubber industries throughout the world; b. New Haven, Conn., 1800; in 1839, by the accidental mixture of a bit of rubber and sulphur on a red-hot stove, he discovered the process of vulcanization. The Goodyear patents proved immensely profitable.

Samuel F. B. Morse, inventor and patentee of electric telegraph; b. Charlestown, Mass., 1791; d. 1872; artist painter; exhibited first drawings of telegraph 1832; half-mile wire in operation 1835; caveat 1837; Congress appropriated $30,000 and in 1844 first telegraph line from Washington to Baltimore was opened; after long con-

tests the courts sustained his patents and he realized from them a large fortune.

Elias Howe, inventor of the modern sewing machine; b. Spencer, Mass., 1819; d. 1867; machinist; sewing machine patented 1846; from that time to 1854 his priority was contested and he suffered from poverty, when a decision of the courts in his favor brought him large royalties, and he realized several millions from his patent.

James B. Eads; b. 1820; author and constructor of the great steel bridge over the Mississippi at St. Louis, 1867, and the jetties below New Orleans, 1876. His remarkable energy was shown in 1861 when he built and delivered complete to the Government, all within sixty-five days, seven iron-plated steamers, 600 tons each; subsequently other steamers. Some of the most brilliant successes of the Union arms were due to his extraordinary rapidity in constructing these vessels.

Prof. Joseph Henry; b. Albany, N. Y., 1799; d. 1878; in 1828 invented the present form of the electro-magnet which laid the foundation for practically the entire electrical art and is probably the most important single contribution thereto. In 1831 he demonstrated the practicability of the electric current to effect mechanical movements and operate signals at a distant point, which was the beginning of the electro-magnetic telegraph; he devised a system of circuits and batteries, which contained the principle of the relay and local circuit, and also invented one of the earliest electro-magnetic engines. He made many scientific researches in electricity and general physics and left many valuable papers thereon. In 1826 he was a professor in the Albany Academy; was Professor of Natural Philosophy at the College of New Jersey in 1832, and in 1846 was chosen secretary of the Smithsonian Institution at Washington, where he remained until his death. Prof. Henry was probably the greatest of American physicists.

Dr. Alexander Graham Bell, the inventor of the telephone; b. 1847 at Edinburgh, Scotland, moved to Canada 1872 and afterward to Boston; here he became widely known as an instructor in phonetics and as an authority in teaching the deaf and dumb; in 1873 he began the study of the transmission of musical tones by telegraph; in 1876 he invented and patented the speaking telephone, which has become one of the marvels of the nineteenth century and one of the greatest commercial enterprises of the world; in 1880 the French Government awarded him the Volta prize of $10,000 and he has subsequently received the ribbon of the Legion of Honor from France and many honorary degrees, both at home and abroad; Dr. Bell still continues his scientific work at his home in Washington and has made valuable contributions to the phonograph and aerial navigation.

[Prof. Bell is now generally known as Dr. Bell, out of respect for his honorary degree.]

Thomas A. Edison; b. 1847, at Milan, Ohio; from a poor boy in a country village, with a limited education, he has become the most fertile inventor the world has ever known; his most important inventions are the phonograph in 1877, the incandescent electric lamp, 1878; the quadruplex telegraph, 1874-1878; the electric pen, 1876; magnetic ore separator, 1880, and the three-wire electric circuit, 1883; his first patent was an electric vote-recording machine, taken in 1869, since which time more than 700 patents have been granted him; early in life Edison started to run a newspaper, but his genius lay in the field of electricity, where as an expert telegrapher he began his great reputation; his numerous inventions have brought him great wealth; a fine villa in Llewellyn Park, at Orange, N. J., is his home, and his extensive laboratory near by is still the scene of his constant work; he is the world's most persevering inventor.

Captain John Ericsson; b. 1803 in Sweden; d. in New York, 1889; at 10 years of age, designed a sawmill and a pumping engine; made and patented many inventions in England in early life; in 1829 entered a locomotive in competition with Stephenson's Rocket; in 1836 patented in England his double-screw propeller and shortly after came to the United States and incorporated it in a steamer; in 1861, built for the United States Government the turret ironclad Monitor; was the inventor of the hot-air engine which bears his name; also a torpedo boat which was designed to discharge a torpedo by means of compressed air beneath the water; he was an indefatigable worker and made many other inventions; his diary, kept daily for 40 years, comprehended 14,000 pages.

Charles F. Brush; b. near Cleveland, Ohio, 1849; prominently identified with the development of the dynamo,

the arc light and the storage battery, in which fields he made many important inventions; in 1880 the Brush Company put its electric lights into New York City and has since extended its installations into most of the cities and towns of the United States; in 1881, at the Paris Electrical Exposition, he received the ribbon of the Legion of Honor.

George Westinghouse, Jr.; b. at Central Bridge, N. Y., 1846; while still a boy he modeled and built a steam engine; his first profitable invention was a railroad frog; his most notable inventions, however, were in railroad airbrakes, the first patents for which were taken out in 1872; the system now known by his name has grown to almost universal adoption and constitutes a great labor saving and life saving adjunct to railroad transportation; Mr. Westinghouse, whose home is at Pittsburg. was one of the earliest to develop and use natural gas from deep wells; in late years he has made and patented many inventions in electrical machinery for the development of power and light, and has commercially developed the same on a large scale.

Ottmar Mergenthaler; b. 1854, at Würtemberg, Germany; d. 1899; inventor of the linotype machine; his early training as a watch and clock maker well fitted him for the painstaking and complicated work of his life, which was to make a machine which would mold the type and set it up in one operation; in 1872 Mergenthaler came to Baltimore and entered a machine shop, in which he subsequently became a partner; the first linotype machine was built in 1886 and put to use in the composing room of the New York Tribune; to-day all large newspaper and publishing houses are equipped with great batteries of these machines, costing over $3,000 each, and each performing the work of five compositors.

The first recorded patent granted by the United States Government bears date July 31, 1790, issued to Samuel Hopkins, for making pot and pearl ashes. Two other patents were granted in that year. In the following year, 1791, thirty-three patents were granted. Among them were six patents to James Rumsay and one to John Fitch for inventions relating to steam engines and steam vessels. For the single year of 1876 the number of patents and caveats applied for was almost 20,000.

PROGRESS OF INVENTIONS.

Below is given in chronological order a list of important inventions beginning with the 16th century, with the title of the invention, the year it was made, the name of the inventor and his nativity:

Inventions.	Date.	Inventor.	Nativity.
Discoveries of electrical phenomena. Won the title of "founder of the science of electricity."	1560 1603	William Gilbert	England
Screw printing-press	1620		
Spirally grooved rifle barrel	1620	Blaew	Germany
Iron furnaces	1621	Koster	England
The use of steam	1630	Lord Dudley	England
The first authentic reference in English literature to the use of steam in the arts.		David Ramseye	England
Bay Psalm Book, first book published in the Colonies	1640		Mass.
Barometer	1643	Torricelli	Italy
Steam engine, atmospheric pressure	1663	Thomas Newcomen	England
Machine for generating electricity	1681–6	Otto von Guericke	Germany
First paper mill in America	1690	William Rittenhouse	Penna.
First steam engine with a piston	1690	Denys Papin	France
The manufacture of plate glass established	1695		France
First to discover difference between electric conductors and insulators	1696 1736	Stephen Gray	England
The first practical application of the steam engine	1702	Thomas Savery	England
First newspaper in America, "Boston News Letter"	1704	John Campbell	Mass.
First to produce electric spark	1708 1716	Dr. J. Wall	England

PROGRESS OF INVENTIONS—*Continued.*

Inventions	Date.	Inventor.	Nativity.
Thermometer	1709	Fahrenheit	Danzig
Electrometer, the well-known pith ball	1718 1772	John Cantor	England
The "Franklin" printing-press	1725	Benjamin Franklin	Utd. States
Electrical glass plate machine	1727 1772	Martin de Planta	France
Stereotyping	1731	William Ged	Scotland
First to discover that electricity is of two kinds.	1733–9	Cisternay du Fay	France
Flying shuttle in weaving	1733	John Kay	England
Rotary 3-color printing-press (multi-color)	1743	Platt & Keen	England
Electric or Leyden Jar	1745	Kleist	Germany
Substitution of coke for coal in melting iron	1750	Abraham Darby	England
Lightning conductor	1752	Benjamin Franklin	Utd States
Spinning jenny	1763	James Hargreaves	England
Pianoforte, played in public in England in	1767		England
Drawing rolls in a spinning machine	1769	Richard Arkwright	England
The introduction of the "Hollander" or beating engine for pulping rags in the manufacture of paper	1773		
The mule spinner	1774	Samuel Crampton	England
Cut nails	1775	Jeremiah Wilkinson	Utd. States
Circular wood saw	1777	Miller	England
Embryo bicycle	1779	Branchard & Magurier	France
Steam engine, the basis of the modern engine	1782	James Watt	Scotland
Gas balloon	1783	J. E. & J. M. Montgolfier	France
Puddling iron	1783–4	Henry Cort	England
Plow, with cast-iron mold board, and wrought- and cast-iron shares	1784	James Small	Scotland
Power loom	1785	James Cartwright	England
First steamboat in the United States	1786	John Fitch	Utd. States
Steam road wagon (first automobile)	1787	Oliver Evans	Utd. States
Grain threshing machine	1788	Andrew Meikle	England
Hobby horse, forerunner of bicycle	1790		England
Rotary steam power printing-press, the first idea of	1790	Wm. Nicholson	England
Wood planing machine	1791	Samuel Bentham	England
Gas first used as an illuminant	1792	Wm. Murdoch	England
Cotton gin	1794	Eli Whitney	Utd. States
Art of lithography	1796	Alois Senefelder	Germany
Machine for making continuous webs of paper.	1800	Louis Robert	France
Electric battery discovered	1800	Volta	Italy
Steam coach	1801	Richard Trevithick	England
Wood mortising machine	1801	M. J. Brunel	England
Pattern loom	1801	M. J. Jacquard	France
First fire-proof safe	1801	Richard Scott	England
Steamboat on the Clyde, "Charlotte Dundas".	1802	William Symington	England
First photographic experiments	1802	Wedgwood & Davy	England
Planing machine	1802	J. Bramah	England
The application of steam to the loom	1803	William Horrocks	England
Steel pen	1803	Wise	England
Steam locomotive on rails	1804	Richard Trevithick	England
Application of twin-screw propellers in steam navigation	1804	John Stevens	Utd. States
Process of making malleable-iron castings	1804	Lucas	England
First life preserver	1805	John Edwards	England
Electro-plating	1805	Luigi Brugnatelli	Italy
Knitting machine, the latch needle in the	1803	Jeandeau	France
Steamboat navigation on the Hudson River	1807	Robert Fulton	Utd. States
Percussion or detonating compound	1807	A. J. Forsyth	Scotland
First street gas lighting in England	1807	F. A. Winsor	England
Band wood saw	1808	Newberry	England
Voltaic arc	1808	Sir Humphry Davy	England
First steamboat to make a trip to sea, the "Phœnix"	1808	John Stevens	Utd. States
Multi-wire telegraphy	1809	Sommering	Germany
Revolving cylinder printing-press	1810	Frederick Koenig	Germany
Breech-loading shotgun	1811	Thornton & Hall	Utd. States
Storage battery	1812	J. B. Ritter	Germany
Dry pile (prototype of dry battery)	1812	Zamboni	Italy
First practical steam rotary printing-press, paper printed on both sides	1814	Frederick Koenig	Germany

PROGRESS OF INVENTIONS—*Continued.*

Inventions.	Date.	Inventor.	Nativity.
First locomotive in United States	1814	George Stephenson	England
First circular wood saw made in this country	1814	Benjamin Cummings	Utd. States
Heliography	1814	Jos. N. Niepce	France
Kaleidoscope	1814	Sir David Brewster	England
Miners' safety lamp	1815	Sir Humphry Davy	England
Dry gas meter	1815	S. Clegg	England
Knitting machine	1816	Brunel.	England
"Draisine" bicycle	1816	Baron von Drais	Germany
"Columbian" press, elbowed pulling bar, number of impressions per hour, 50	1817	George Clymer	Utd. States
Stethoscope	1819	Laënnec	France
Electro-magnetism discovered	1819	H. C. Oersted	Germany
Lathe for turning irregular wood forms	1819	Thomas Blanchard	Utd. States
The theory of electro-dynamics first propounded	1820	Andre Ampère	France
Electroscope	1820	Bohenberg	Germany
The conversion of the electric current into mechanical motion	1821	Michael Faraday	England
Galvanometer	1822	Schweigger	Germany
Multi-color printing	1822	P. Force	Utd. States
Calculating machine	1822	Charles Babbage.	England
Discovery of thermo-electricity	1823	Prof. Seebeck	England
Liquefaction and solidification of gas	1823	Michael Faraday	England
Water gas, discovery of	1823	Ibbetson	England
Portland cement	1825	Joseph Aspdin	England
Electro-magnet	1825	Sturgeon	England
First passenger railway, opened between Stockton and Darlington, England	1825		
Electrical spur wheel	1826	Barlow	England
First railroad in United States, near Quincy, Mass.	1826		
The law of galvanic circuits formulated	1827	George S. Ohm	Germany
Friction matches	1827	John Walker	Utd. States
The reduction of aluminum	1827	Friedrich Wohler	Germany
Law of electrical resistance	1827	George S. Ohm	Germany
Improved rotary printing-press, London Times, 5,000 impressions per hour	1827	Cowper & Applegarth	England
Hot air blast for iron furnaces	1828	J. B. Neilson	Scotland
Wood planing machine	1828	William Woodworth	Utd. States
Spool electro-magnet	1828	Joseph Henry	Utd. States
Tubular locomotive boiler	1828	Séquin	France
Spinning ring frame	1828	John Thorp	England
The "Washington" printing-press, lever motion and knuckle joint for a screw, number of impressions per hour, 200	1829	Samuel Rust	Utd. States
First steam locomotive in United States, "Stourbridge Lion"	1829		
Double fluid galvanic battery	1829	A. C. Becquerel	France
First portable steam fire engine	1830	Brathwaite & Ericsson	England
Magneto-electric induction	1831	Michael Faraday	England
Chloroform	1831	G. J. Guthrie	Scotland
First conception of electric telegraph	1832	Prof. S. F. B. Morse	Utd. States
First magneto-electric machines	1832	Saxton	Utd. States
Rotary electric motor	1832	Wm. Sturgeon	England
Chloral-hydrate	1832	Justus von Liebig	Germany
Locomotive, "Old Ironsides," built	1832	M. W. Baldwin	Utd. States
Link-motion for locomotives	1832	Sir Henry James	England
Adoption of steam whistle for locomotives	1833	George Stephenson	England
Reciprocating saw-tooth cutter within double guard fingers for reapers	1833	Obed Hussey	Utd. States
"McCormick" reaper	1834	Cyrus H. McCormick	Utd. States
Rotary electric motor	1834	M. H. Jacobi	Russia
Carbolic acid discovered	1834	Runge	Germany
Horseshoe machine	1835	H. Burden	Utd. States
Constant electric battery	1836	J. P. Daniell	England
Acetylene gas discovered	1836	Edmund Davy	England
The revolver; a device "for combining a number of long barrels so as to rotate upon a spindle by the act of cocking the hammer"	1836	Samuel Colt	Utd. States
The screw applied to steam navigation	1836 1841	John Ericsson	Utd. States
The galvanizing of iron	1837	Henry Craufurd	England

PROGRESS OF INVENTIONS—*Continued.*

Inventions.	Date.	Inventor.	Nativity.
Indicator-telegraph	1837	Cooke & Wheatstone	England
Photographic carbon printing	1838	Mungo Ponton	France
Babbitt metal	1839	Isaac Babbitt	Utd. States
Vulcanization of rubber	1839	Charles Goodyear	Utd. States
The first boat electrically propelled	1839	Jacobi	Germany
Daguerreotype (First to produce a direct photographic positive in the camera by means of highly polished silver surfaced plate exposed to the vapors of iodine and subsequent development with mercury vapor.)	1839	Louis Daguerre	France
Making photo-prints from paper negatives (First production of positive proofs from negatives.)	1839	Fox Talbot	England
Photographic portraits (Daguerreotype process.)	1839	Profs. Draper & Morse	Utd. States
First incandescent electric lamp	1840	Grove	England
Celestial photography	1840	Draper	Utd. States
Artesian well	1840		Paris
Pneumatic caissons	1841	M Triger	France
Pianoforte automatically played	1842	M. Seytre	France
Water gas, utilization of	1842	Selligne	France
Steam hammer	1842	James Nasmyth	Scotland
Typewriting machine	1843	Charles Thurber	Utd. States
First telegram sent	1844	Prof. S. F B. Morse	Utd. States
The use of nitrous oxide gas as an anæsthetic	1844	Dr. Horace Wells	Utd. States
The electric arc light (gas retort carbon in a vacuum)	1844	Léon Foucault	France
First telegraphic message, Washington, Baltimore	1844	Prof. S. F. B. Morse	Utd. States
Automatic adjustment of electric arc light carbons	1845	Thomas Wright	England
Double cylinder printing-press	1845	R. Hoe & Co.	Utd. States
Pneumatic tire	1845	R. W. Thompson	England
Sewing machine	1846	Elias Howe	Utd. States
Printing telegraph	1846	House	Utd. States
Suez canal started	1846	De Lesseps	France
Ether as an anæsthetic	1846	Dr. Morton.	Utd. States
Electric cautery	1846	Crusell	Russia
Artificial limbs	1846		
Gun cotton	1846	Schönbein	Germany
First pianoforte keyboard player	1846	Debain	France
Chloroform in surgery	1847	Dr. Simpson	Scotland
Nitro-glycerine	1847	Sobrero	
Time-lock	1847	Savage	Utd. States
Hoe's lightning press, capable of printing 20,000 impressions per hour	1847	Richard M. Hoe	Utd. States
Match-making machinery	1848	A. L. Dennison	Utd. States
Breech gun-lock, interrupted thread	1849	Chambers	Utd. States
Magazine gun	1849	Walter Hunt.	Utd. States
Steam pressure gauge	1849	Bourdon	France
Lenticular stereoscope	1849	Sir David Brewster	England
Latch needle for knitting machine	1849	J. T. Hibbert	Utd. States
"Corliss" engine	1849	G. H. Corliss	Utd. States
Printing-press, curved plates secured to a rotating cylinder	1849	Jacob Worms	France
Mercerized cotton	1850	John Mercer	England
Collodion process in photography	1850	Scott Archer	England
American machine-made watches	1850		Utd. States
Electric locomotive	1851	Dr Page	Utd. States
Self-raker for harvesters	1851	W. H. Seymour	Utd. States
Breech-loading rifle	1851	Maynard	Utd. States
Icemaking machine	1851	J. Gorrie	Utd. States
Ophthalmoscope	1851	Helmholtz	Germany
The Ruhmkorff coil	1851	Ruhmkorff	Germany
Fire-alarm telegraph	1852	Channing & Farmer	Utd. States
Reticulated screen for half-tone photographic printing	1852	Fox Talbot	England
Soda process of making pulp from wood	1853	Watt & Burgess	Utd. States
Laws of magneto-electric induction	1853	Michael Faraday	England
Laws of electro-statics	1853	Michael Faraday	England

PROGRESS OF INVENTIONS—*Continued.*

Inventions.	Date.	Inventor.	Nativity.
Electrolysis	1853	Michael Faraday	England
Duplex telegraph	1853	Gintl	Austria
Photographic roll films	1854	Melhuish	England
Diamond rock drill	1854	Herman	Utd. States
Four-motion feed for sewing machines	1854	A. B. Wilson	Utd. States
Magazine firearm	1854	Smith & Wesson	Utd. States
Fat decomposed by water or steam at high temperature, since largely used in soap making	1854	R. A. Tilghman	Utd. States
Safety matches	1855	Lundstrom	Sweden
Iron-clad floating batteries first used in Crimean war	1855		
Cocaine	1855	Gaedeke	Germany
Process of making steel, blowing air through molten pig iron	1855	Sir Henry Bessemer	England
Dryplate photography	1855	Dr. J. M. Taupenot	
Bicycle	1855	Ernst Michaux	France
Sleeping car	1856	Woodruff	Utd. States
Aniline dyes	1856	Perkins	England
Printing machine for the blind (contains elements of the present typewriting machine)	1856	Alfred E. Beach	Utd. States
Regenerative furnace	1856	Wm. Siemens	England
Refining engine in paper pulp making	1856	T. Kingsland	Utd. States
Coal-oil first sold in the United States	1857	Messrs. Stout & Hand	Utd. States
First sea-going iron-clad war vessel, the "Glorie"	1857		France
Ground wood pulp	1858	Henry Voelter	Germany
Inclined elevator and platform in the reaper	1858	J. S Marsh	Utd. States
Cable car	1858	E. A. Gardner	Utd. States
Breech-loading ordnance	1858	Wright & Gould	Utd. States
Feed injector for boilers	1858	Giffard	France
First Atlantic cable	1858	Cyrus Field	Utd. States
Great Eastern launched	1859		
Storage or secondary battery	1860	Gaston Planté	France
Singing telephone	1860	Philip Reis	Germany
Ammonia absorption ice machine	1860	F P. E. Carré	France
Improved stereotyping process	1861	Charles Craske	Utd. States
Shoe-sewing machine	1861	George McKay	Utd. States
Driven well, a tube with a pointed perforated end driven into the ground	1861	Col. N. W. Green	Utd. States
Passenger elevator	1861	E. G. Otis	Utd. States
Barbed-wire fence introduced	1861		Utd. States
Calcium carbide produced	1862	Frederich Woehler	Germany
Revolving turret for floating battery	1862	Theodore Timby	Utd. States
First iron-clad steam battery, "Monitor"	1862	John Ericsson	Utd. States
Gatling gun	1862	Dr. R. J. Gatling	Utd. States
Smokeless gunpowder	1863	J. F. E. Schultze	Prussia
Pneumatic pianoforte player (regarded as first to strike keys by pneumatic pockets)	1863	M. Fourneaux	France
Explosive gelatine	1864	A. Nobel	France
Rubber dental plate	1864	J. A. Cummings	Utd. States
Automatic grain-binding device	1864	Jacob Behel	Utd. States
Process of making fine steel	1865	Martin	Utd. States
Antiseptic surgery	1865	Sir Joseph Lister	England
Web-feeding printing-press	1865	William Bullock	Utd. States
Automatic shell ejector for revolver	1865	W. C. Dodge	Utd. States
Open-hearth steel process	1866	Siemens-Martin	England
Compressed air rock drill	1866	C. Burleigh.	Utd. States
Torpedo	1866	Whitehead	Utd. States
Dynamo electric machine	1866	Wilde	England
Sulphite process for making paper pulp from wood	1867	Tilghman	Utd. States
Dynamo electric machine	1866	Siemens	Germany
Disappearing gun carriage	1868	Moncrief	England
First practical typewriting machine	1868	C. L. Sholes	Utd. States
Dynamite	1868	A. Nobel	France
Oleomargarine	1868	H. Mege	France
Water heater for steam fire engine	1868	W. A. Brickell	Utd. States
Sulky plow	1868	B. Slusser	Utd. States
Railway air-brake	1869	George Westinghouse	Utd. States
Tunnel shield (operated by hydraulic power)	1869	Alfred E. Beach	Utd. States
A curved spring tooth harrow	1869	David L. Garver	Utd. States

PROGRESS OF INVENTIONS—*Continued.*

Inventions.	Date.	Inventor.	Nativity.
Dynamo-electric machine	1870	Gramme	France
Celluloid	1870	J. W. & Isaac Hyatt	Utd. States
Rebounding gun-lock	1870	L. Hailer	Utd. States
The Goodyear welt shoe-sewing machine	1871	Goodyear	Utd. States
Photographic gelatino-bromide emulsion (basis of present rapid photography)	1871	R. L. Maddox	England
Continuous web printing-press	1871	Hoe & Tucker	Utd. States
Grain binder	1871	S. D. Locke	Utd. States
Compressed air rock drill	1871	S. Ingersoll	Utd. States
Positive motion weaving loom	1872	J. Lyall	Utd. States
Theory that light is an electric phenomenon	1872	Clerk Maxwell	England
Automatic air brake	1872	George Westinghouse	Utd. States
Automatic car coupler	1873	E. H. Janney	Utd. States
The photographic platinotype process. (Prints by this process are permanent.)	1873	Willis	England
Quadruplex telegraph	1873	T. A. Edison	Utd. States
Twine binder for harvesters	1873	M. L. Gorham	Utd. States
Gelatino-bromide photographic emulsion (sensitiveness to light greatly increased by the application of heat)	1873	Charles Bennett	England
Self-binding reaper	1873	Locke & Wood	Utd. States
Barbed-wire machine	1874	Glidden & Vaughan	Utd. States
Siphon recorder for submarine telegraphs	1874	Sir William Thompson	England
Store cash carrier	1875	D. Brown	Utd. States
Illuminating water gas	1875	T. S. C. Lowe	Utd. States
Roller flour mills	1875	F. Wegmann	Utd. States
Middlings purifier for flour	1875	Geo. T. Smith	Utd. States
Ice-making machine	1875	R. P. Pictet	Switzerland
Speaking telephone	1876	Alex. G. Bell	Utd. States
Electric candle. (The first step towards the division of the electric current for lighting.)	1876	Paul Jablochkoff	Russia
Continuous machine for making tobacco cigarettes	1876	Russell	Utd. States
Steam feed saw mills	1876	D. C. Prescott	Utd. States
The first Portland cement plant in U. S.	1876		Coplay, Pa.
Phonograph	1877	T. A. Edison	Utd. States
Gas engine	1877	N. A. Otto	Utd. States
Carbon microphone	1877	T. A. Edison	Utd. States
Telephone transmitter of variable resistance	1877	Emil Berliner	Utd. States
Carbon filament for electric lamp. (Beginning of the incandescent vacuum electric light.)	1878	T. A. Edison	Utd. States
Rotary disk cultivator	1878	Mallon	Utd. States
Decided advance in the "expression" of self-playing pianofortes	1878	Gally	Utd. States
Automatic grain binder	1879	J. F. Appleby	Utd. States
Cathode rays discovered	1879	Sir Wm. Crookes	England
Electric railway	1879	Siemens	Germany
Steam plow	1879	W. Foy	Utd. States
Magazine rifle	1879	Lee	Utd. States
"Blake" telephone transmitter	1880	Blake	Utd. States
Hammerless gun	1880	Greener	Utd. States
Storage battery or accumulator	1880	Camille A. Faure	France
Typhoid bacillus isolated	1880	Eberth & Koch	Germany
Pneumonia bacillus isolated	1880	Sternberg	Utd. States
Button-hole machine	1881	Reece	Utd. States
Improvement in "expression" of self-playing pianofortes	1882	Schmaele	Utd. States
Hand photographic camera for plates	1881	Wm. Schmid	Utd. States
Tuberculosis bacillus isolated	1882	Robert Koch	Germany
Hydrophobia bacillus isolated	1882	Louis Pasteur	France
Cholera bacillus isolated	1884	Robert Koch	Germany
Diphtheria bacillus isolated	1884	Loeffler	Germany
Lockjaw bacillus isolated	1884	Nicolaier	France
Antipyrene	1884	Kuno	Utd. States
Linotype machine	1884	Ottmar Mergenthaler	Germany
The rear-driven chain safety bicycle	1884	George W. Marble	Utd. States
Chrome tanning of leather	1884	Schultz	Utd. States
Process of reducing aluminum	1885	Cowles	England
Gas burner	1885	Carl Welsbach	Germany

PROGRESS OF INVENTIONS—*Continued.*

Inventions.	Date.	Inventor.	Nativity.
Hydraulic dredge	1885	Bowers	Utd. States
First electric railway in United States, Hampden and Baltimore, Md	1885		
Contact device for overhead electric trolley	1885	C. J. Van Depoele	Utd. States
Graphophone	1886	Bell & Tainter	Utd. States
Electric welding	1886	Elihu Thompson	Utd. States
Combined harvester and thresher	1886	Matteson	Utd. States
Band wood saw	1887	D. C. Prescott	Utd. States
Cyanide process of obtaining gold and silver	1887	McArthur & Forrest	Utd. States
System of polyphase electric currents	1887	Nicola Tesla	Utd. States
Incandescent gas light. (The formation of a cone-shaped interwoven mantle of thread coated with a refractory rare earth and rendering the same incandescent by the heat rays of a Bunsen gas burner regardless of how the gas is produced.)	1887	Carl A. Von Welsbach	Austria
Process of annealing armor plate	1888	Harvey	Utd. States
"Kodak" snap-shot camera. (Constructed to use a continuous sensitized ribbon film.)	1888	Eastman & Walker	Utd. States
Process of making artificial silk	1888	H. DeChardonnet	France
Hertzian waves or electric-wave radiation	1888	Heinrich Hertz	Germany
First rotary cement kilns in U. S	1889		Coplay, Pa.
Nickel steel	1889	Schneider	Utd. States
Process for making aluminum	1889	Chas. M. Hall	Utd. States
Electric plow	1890	W. Stephens	Utd. States
Improved linotype machine	1890	Ottmar Mergenthaler	Germany
Bicycles equipped with pneumatic tires	1890		
Krag-Jörgensen magazine rifle	1890	Krag-Jörgensen	Utd. States
"Coherer" for receiving electric waves	1891	Edouard Branly	England
Rotary steam turbine	1891	C. A. Parsons	England
Cement-lined paper-pulp digester	1891	G. F. Russell	Utd. States
Round bale cotton press	1891	Brown	Utd. States
Microphone	1891	Emile Berliner	Utd. States
Power loom	1891	Northrup	Utd. States
Commercial application of formic-aldehyde	1892	J. J. A. Trillat	France
Shoe-last lathe, for different lengths?	1893	Kimball	Utd. States
Kinetoscope	1893	T. A. Edison	Utd. States
Process for making carborundum	1893	E. G. Acheson	Utd. States
Calcium carbide produced in electric furnace	1893	Thos. L. Willson	Utd. States
Process for liquefying air	1895	Carl Linde	Germany
Electric locomotive, B. & O. Bell Tunnel	1895		Utd. States
X-rays	1895	Prof. W. C. Roentgen	Germany
Acetylene gas from calcium carbide	1895	Thomas L. Willson	Utd. States
System of wireless telegraphy	1896	G. Marconi	Italy
Foundation laid of science of radio-activity, i.e., emanation of penetrating rays from luminescent bodies	1896	Henri Becquerel	France
Use of ultra-violet rays in treating diseases	1896	Niels R. Finsen	Denmark
Nernst electric light. (Method of rendering a clay compound capable of conducting electricity and thence becoming brilliantly incandescent without a vacuum.)	1897	Walter Nernst	Germany
Mercury vapor electric light. (An artificial light composed strictly of the ultra-blue violet rays of the spectrum obtained by passing an electric current through a partial vacuum tube filled with mercury vapor, the latter acting as a conductor. Possesses remarkable actinic power for photographic purposes.)	1900	Peter Cooper Hewitt	Utd. States
Air-ship	1901	M. Santos-Dumont	France
Automobile mower	1901	Deering Harvester Co	Utd. States
The first passenger steam turbine ship, "Edward VII."	1901	Denny & Brothers	England
The first oil-burning steamship built in the United States, "Nevada"	1902		
English Pacific cable, Canada-Australia	1902		
American Pacific cable	1903		Utd. States
Berlin-Zossen Road, 130½ miles an hour	1903		Germany

—*Encyclopedia Americana.*

GENERAL INFORMATION REGARDING PATENTS.

WHAT IS A PATENT?—The term *patent* or *letters patent* is derived from *litterae patentes*, signifying that which is open or disclosed in contradistinction to *lettre de cache*, that which is sealed or secret. This term is the keynote of the whole principle upon which the patent system is built up, namely, disclosure. The disclosure must be honest, absolute and unreserved. The penalty for mental crookedness or for ignorance in giving out fully and freely the nature of the invention is severe and direct and is nothing less than forfeiture of the patent itself. The reason for this is perfectly logical and arises from the very meaning, spirit and nature of the relationship existing between the patentee and the government. The term of a patent is 17 years. During this term of 17 years the patentee obtains a monopoly under which he secures exclusive right of manufacture, use and sale. The patent itself, however, is in the nature of a contract between the patentee and the government, presumably for their mutual benefit. The government grants to the inventor the exclusive right of manufacture and sale for 17 years on condition that the inventor shall disclose fully the nature of his invention or discovery, and shall allow the public the unrestricted use of the invention after this term has expired. If he fail in making full disclosure, he has not lived up to the terms of the implied contract and the patent thereby becomes null and void. It sometimes happens that an inventor discloses freely part of the invention, but cunningly conceals some essential step in the process, but if the case is tested within the courts and the real facts are brought to light, the patent will be declared invalid. At the end of the term of 17 years the patent becomes public property, and the article may be freely manufactured by any one. It can never thereafter, as in so many cases in the Middle Ages, become a lost art.

WHO MAY OBTAIN A PATENT?—In order to secure a valid patent, the applicant must declare upon oath that he believes himself to be the true, original and first inventor or discoverer of the art, machine, manufacture, composition or improvement for which he solicits a patent; that he does not know and does not believe that the same was ever before known or used; and that the invention has not been in public use or on sale in the United States for more than two years before the application was filed, and that the invention has not been described in any printed publication for more than two years prior to the filing of the application. Any one who can subscribe to the above conditions may apply for a patent, irrespective of race, color, age, or nationality. Minors and women and even convicts may apply for patents under our law. The rights even of a dead man in an invention are not lost, for an application may be filed in his name by his executor or administrator, and the rights of his heirs thereby safeguarded. The patent in this case would issue to the executor or administrator and would become subject to the administration of the estate like any other property left by the deceased. Even the rights of an insane person may not be lost, as the application may be filed by his legal guardian. If foreign patents for the same invention have been previously issued, having been filed more than 12 months before the filing of the United States application, the patent would be refused. The applicant must state his nationality. It often happens that two or more individuals have jointly worked upon the invention, and in this case the several inventors should jointly apply for the patent. Should they not so apply, the patent when issued would be invalid. If they are merely partners, however, and not co-inventors, they should not apply jointly for a patent, as the inventor alone is entitled to file the application. He may, however, assign a share in the patent to his partner, coupled with the request that the patent should issue to them jointly. It is of the greatest importance that these distinctions should be clearly understood; otherwise, the patent may be rendered invalid.

WHAT MAY BE PATENTED?—Any *new and useful* art, machine, manufacture or composition of matter, or any new and useful improvements thereon. The thing invented must be *new and useful*. These are conditions precedent to the granting of a patent. Of these two conditions by far the more important is the former, and it is concerning the interpretation of this word "*new*" and its bearing upon the invention that the principal work and labor involved in passing an application safely through the Patent Office is involved. When the invention has been worked

out by the inventor and he is prepared to file his application, his attorney prepares the necessary papers, as provided for by law, namely: An Oath, a Petition, a Specification consisting of a description of the invention and concluding with claims which specifically set forth what the inventor claims to be the novel features of the invention, and drawings which are prepared and filed with the case, and in due course the application is ready for examination in the Patent Office. The question of whether the invention is *new* is then considered, and the burden of proof that the invention is not new rests upon the Patent Office. The examination consists in searching through the files of the Patent Office among the patents that have been already issued, and through such literature as may bear upon the subject. If any reference is discovered that anticipates the invention, as defined by the claims of the specification, the applicant is informed of the fact, and he is allowed to amend his papers and narrow the claims so as to avoid the prior patents, if possible. If his attorney considers the position of the Patent Office untenable, he may present arguments to show wherein he believes that the inventor is entitled to a patent. It is thus seen that the question of whether an invention is new is one of fact, and one of the greatest importance, and upon the showing that the inventor is able to make during the prosecution of the case, depends largely the future success of the patent. The evidence adduced in proving that the invention is not new must be tangible and accessible. A patent would not be refused or overturned on a mere mental concept. There must be some evidence of a substantial character that serves to show that the earlier idea was reduced to practice or at least that there was such a description or drawing made, as would be sufficient for one skilled in the art to reduce the invention to practice. If it has not been actually reduced to practice, it must be a concrete not an abstract idea.

It is essential that the application for a patent should be filed before the invention has been in public use or on sale for a period of two years. If the inventor has publicly used or sold his invention for a period of two years, it becomes public property and he cannot regain the right to obtain a patent. He may, however, make models and experiment with his invention for a much longer period, provided he does not disclose his invention to the public or put it into actual use or on sale for a period of two years. The word "useful" is not one which usually gives either the Patent Office or the inventor a great deal of trouble, as any degree of utility, however insignificant, will serve to entitle the inventor to a patent. It has often happened that an invention which appears, at the time the patent is applied for, to have no special utility, in later years, owing to new discoveries or improvements in the arts, is found to possess the greatest merit and value. Unless an invention is positively meretricious, therefore, it is difficult to assume that it either has no utility or never will have any. Patents are granted for "any new and useful art, machine, manufacture or composition of matter, or any improvement thereon." It is seen from the terms of the statute that almost any creature of the inventive faculty of man becomes a proper subject for a patent. The exceptions are very few. Patents will not be granted, for example, for any invention that offends the law of nature. Under this category may be mentioned perpetual motion machines. In case an application of this character is presented, the Commissioner politely informs the applicant that the matter cannot be considered until a working model demonstrating the principle of the invention has been deposited in the Patent Office. Inventions of an immoral nature will not be considered. Medicines and specifics are not now proper subjects for letters patent, unless some important new discovery is involved.

PATENTED ARTICLES MUST BE MARKED.—Articles manufactured and sold under a patent must be so marked that the public shall have notice that the article is a patented one. This notice consists of the word "Patented," together with the date when the patent was issued or the Serial Number of the patent. Damages in an infringement suit cannot be recovered unless the defendant has received such notice that the article is patented. The term of a United States patent is 17 years. This term cannot be extended except by special Act of Congress. It is many years since a bill seeking an extension of the term of a patent has been passed by Congress.

APPEALS.—If an application for a patent has been rejected, the applicant may appeal from the Primary Examin-

er to the Board of Examiners-in-Chief. He may further carry the appeal to the Commissioner of Patents, and in case he is not satisfied with the latter decision, he may carry the appeal finally to the Court of Appeals of the District of Columbia.

INTERFERENCE.—If two or more individuals shall have invented the same thing at or about the same time, interference proceedings may be instituted to determine which applicant is the original or first inventor. Interference proceedings are instituted between applicants whose applications are pending or between a pending application and a patent already issued, provided the latter patent has not been issued for more than two years prior to the filing of the conflicting application. The proceedings are conducted before the Examiner of Interferences. Appeal may be taken from the Examiner of Interferences to the Board of Examiners-in-Chief, and from the Board of Examiners-in-Chief to the Commissioner, and thence to the Court of Appeals of the District of Columbia. Not all the claims for a patent are necessarily involved, only such as cover the particular feature of the invention which is declared to be in interference. The unsuccessful applicant by eliminating the claims or claim in controversy may procure allowance of the other claims not objected to, and have the patent issued. In determining the question of priority of invention, witnesses are examined and the proceedings are conducted much in the same manner as in a suit at law. The first step in the proceeding consists in filing with the Commissioner a Preliminary Statement made under oath, giving the date at which the invention was first conceived and reduced to some tangible form, such as the making of drawings, the construction of a model, or the disclosing of the invention to another. The object of the subsequent examination and cross-examination is to substantiate the date of invention as claimed by the applicants respectively, and to establish the priority of invention.

INFRINGEMENT.—In case of an action for the infringement of a patent, the importance of the question of novelty appears from the special pleadings which the defendant may enter, which are as follows:

1. That for the purpose of deceiving the public the description and specification filed by the patentee in the Patent Office was made to contain less than the whole truth relative to his invention or discovery, or more than is necessary to produce the desired effect; or,

2. That he had surreptitiously or unjustly obtained the patent for that which was in fact invented by another, who was using reasonable diligence in adapting and perfecting the same; or,

3. That it had been patented or described in some printed publication prior to his supposed invention or discovery thereof; or,

4. That he was not the original and first inventor or discoverer of any material and substantial part of the thing patented; or,

5. That it has been in public use or on sale in this country for more than two years before his application for a patent, or had been abandoned to the public.

Damages for infringement of a patent may be recovered by action on the case in the name of the patentee or his assignee. The courts having jurisdiction over such cases have the power (1) to grant injunctions against the violation of any right secured by the patent; (2) to allow the recovery of damages sustained by the complainant through such infringement. In such a case the defendant is compelled to furnish an accounting showing the amount of the articles manufactured and sold and the profits derived from such sale.

DESIGN PATENTS.—Design patents are issued for any new or original design, whether it be a work of art, statue, bas-relief, design for prints or fabrics, or for any new design or shape or ornament in any article of manufacture. The scope of the design patent was formerly very broad, but recent decisions and enactments have greatly restricted its availability and a design patent cannot now be obtained unless it possesses some inherent artistic quality. Mere utility is not sufficient to entitle a new design to letters patent. The terms of design patents are 3 1-2, 7 or 14 years.

CAVEATS.—Any one who has made a new invention or discovery, which is not yet completed or perfected, may file in the Patent Office a caveat, describing his invention, said caveat serving as notice to the Patent Office that the caveator is in possession of a certain invention partly developed, for which later he proposes to file an application for a patent. The caveat is filed by the Commission in the secret archives of the Patent Office, and is

operative for a term of one year. The term may be prolonged from year to year by the payment of a small fee. The caveat should not be confounded with a patent, for it gives the inventor no real protection or monopoly. It simply entitles him to notice in case another inventor files an application for the same invention. In this event the caveator is entitled to three months' grace within which to file his patent application, whereupon an interference will be declared between the two inventions.

ASSIGNMENTS.—A patent or any interest therein may be sold or assigned like any other piece of property. An inventor may sell or assign his interest or a part interest in his invention, either before the application is filed or while the application is still pending. Under these circumstances the patent may be issued to the assignee or to the inventor and assignee jointly. The patent, if already issued, may be assigned by the owner whether he be the inventor or assignee. The conveyance is effected by an instrument in writing stating the conditions under which the patent is assigned, and the assignment should be recorded in the Patent Office.—Enc. Americana.

ABSTRACTS OF DECISIONS.

Where an inventor has completed his invention, if he neither applies for a patent nor puts it to practical use, a subsequent inventor who promptly applies is entitled to the patent, and the first one is deemed to have abandoned his rights. Pattee v. Russell, 3 O. G., 181; Ex parte Carre, 5 O. G., 30; Johnson v. Root, 1 Fisher, 351.

As between two rival inventors, the test of priority is the diligence of the one first to conceive it. If he has been diligent in perfecting it, he is entitled to receive the patent. If he has been negligent, the patent is awarded to his opponent. Robinson on Patents. Sec. 375.

The construction and use in public of a working machine, whether the inventor has or has not abandoned it, excludes the grant of a patent to a subsequent inventor. An abandonment in such case inures to the benefit of the public and not to the benefit of a subsequent inventor. Young v. Van Duser, 16 O. G., 95.

A mere aggregation or combination of old devices is not patentable when the elements are unchanged in *function and effect.* They are patentable when, "by the action of the elements upon each other, or by their joint action on their common object, they perform additional functions and accomplish additional effects." Robinson on Patents, Sec. 154.

A change of shape enabling an instrument to perform new functions is invention. Wilson v. Coon, 18 Blatch. 532; Collar Co. v. White, 7 O. G., 690, 877.

A patent which is simply for a method of transacting business or keeping accounts is not valid. U. S. Credit System Co. v. American Indemnity Co., 63 O. G., 318.

The law requires that manufacturers of patented articles give notice to the public that the goods are patented by marking thereon the date of the patent or giving equivalent notice. When this law is not complied with, only nominal damages can be recovered. Wilson v. Singer Mfg. Co., 4 Bann. & A. 637; McCourt v. Brodie, 5 Fisher, 384.

To prevent fraudulent impositions on the public it is forbidden that unpatented articles be stamped "Patented," and where this is done with intention to deceive, a penalty of one hundred dollars and costs for each article so stamped is provided. Any person may bring action against such offenders. Walker v. Hawxhurst, 5 Blatch. 494; Tompkins v. Butterfield, 25 Fed. Rep. 556.

A patentee is bound by the limitations imposed on his patent, whether they are voluntary or enforced by the Patent Office, and if he accepts claims not covering his entire invention he abandons the remainder. Toepfer v. Goetz, 41 O. G., 933.

Claims should be construed, if possible, to sustain the patentee's right to all he has invented. Ransom v. Mayor of N. Y. (1856), Fisher, 252.

The assignor of a patented invention is estopped from denying the validity of his own patent or his own title to the interest transferred. He cannot become the owner of an older patent and hold it against his assignee. Robinson on Patents, Sec. 787, and notes.

Any assignment which does not convey to the assignee the entire and unqualified monopoly which the patentee holds in the territory specified, or an undivided interest in the entire monopoly, is a mere license. Sanford v. Messer, 2 O. G., 470.

FOREIGN PATENTS.

CANADA, DOMINION OF.—The laws of Canada follow somewhat closely the practice in the United States. The term of a patent is 18 years. The general practice, however, is to divide the fees, making payment only for a term of six years at one time. Applications are subjected to examination as to novelty and usefulness, as in the United States. The application must be filed in Canada not later than during the year following the issue of the United States or other foreign patent. If the inventor neglects to file his application within the 12 months, the invention becomes public property. It is not permissible to import the patented article into the Dominion after 12 months from the date of the Canadian patent. Within two years from said date the manufacture and sale of the article under the patent must have been begun. These exactions may be relaxed under certain conditions.

GREAT BRITAIN.—The term of the patent is 14 years. After January, 1905, an examination will be made in Great Britain to ascertain whether the invention has been disclosed in the specifications of British patents granted within fifty years of the filing of the British application. While this will be the extent of the examination by the Patent Office, it will be sufficient to invalidate a British patent to show in court that the invention was published, or was in public use, in Great Britain before the priority of the British application. In Great Britain the true inventor should apply for the patent in his own name; but if the invention has been conceived in a foreign country, the first introducer may obtain the patent whether he be the true inventor or not. Under these circumstances, therefore, a foreign assignee may apply for the patent in his own name without the true inventor being known. After the fourth year there are annual taxes, gradually increasing in amount. The patent becomes void if the tax is not paid. No time is set within which the manufacture of the invention must be commenced, but after three years if the manufacture has not been begun, the patentee may be compelled to grant licenses, or the patent may be declared invalid.

FRANCE.—The term of a patent is 15 years. There is no examination as to novelty, and the patent is granted to the first applicant, whether or not he be the true inventor. The life of the patent depends upon the payment of annual taxes. The patent must be worked in France within three years of the filing of the application. If these conditions are not complied with, the patent becomes public property.

GERMANY.—The term of a patent is 15 years. The patent is issued to the first applicant, but if he is not the true inventor he should, before filing the application, obtain the written consent of the inventor. The application is subjected to a rigid examination. The patent is subject to an annual progressive tax, and must be worked within a period of three years.

AUSTRIA.—The term of a patent is 15 years. The practice is somewhat similar to the practice in Germany, although the examination is generally not so exacting. The patent is subject to an annual tax and it must be worked within a period of three years.

HUNGARY.—The term of a patent is 15 years. The laws are similar to those of Germany. There is a progressive annual tax and the patent must be worked within a period of three years.

BELGIUM.—The term of a patent is 20 years. The first applicant obtains the patent whether or not he is the true inventor. There is a small annual tax, and the patent should be worked within three years or within one year of the working elsewhere.

ITALY.—The term of a patent is 15 years. The patent is granted to the first applicant. The patent is subject to an annual tax, and the working must take place within three years.

RUSSIA.—The term of the patent is 15 years. The patent is subject to the payment of annual taxes and must be worked within five years.

SPAIN.—The term of the patent is 20 years, subject to the payment of annual taxes. It must be worked within three years. The patent is issued to the first applicant, whether or not he be the true inventor.

SWITZERLAND.—The term of the patent is 15 years, subject to an annual tax. Working must take place within three years. Only the true inventor or his assignee can obtain a patent.

NORWAY.—Term of patent is 15 years, subject to a small annual tax. The patent must be worked within three years. The application must be filed in the name of the true inventor or his legal representative. Applica-

tion must be filed within six months of the publication of any prior patent.

SWEDEN.—Term of patent is 15 years, subject to payment of an annual tax. The conditions are very similar to the laws of Norway, but the application should be filed before the issuing of a prior foreign patent.

DENMARK.—The laws are similar to those of Sweden.

PORTUGAL.—The term varies from 1 to 15 years, the fees payable depending upon the term of the patent.

HOLLAND has no patent laws.

AUSTRALASIA. — The Australasia patent protects an invention in Victoria, New South Wales, Queensland, South Australia, Tasmania and Western Australia, but not in New Zealand, which has its own patent laws. The term of the Australia patent is 14 years, a tax being due before the expiration of the seventh year. When the patent is not worked the patentee may be required to give license for a reasonable consideration.

NEW ZEALAND.—The term of the patent is 14 years, taxes being due before the end of the fourth and seventh years. There are no requirements as to working.

BRITISH INDIA.—The patent is granted for 14 years, and closely follows the British practice. The application should be filed within one year of the issue of the patent in any other country.

PORTO RICO.—It is possible to procure protection for industrial property by registering a certified copy of the United States patent with the Civil Governor and complying with the other legal formalities.

PHILIPPINES.—The modus operandi is the same as that just described as applying to Porto Rico.

CUBA.—Since Cuba has become an independent republic it has established a patent system. The term of the patent is 17 years. Working should be established within one year. No taxes after the issue of the patent.

MEXICO.—The term is 20 years. There are no taxes after the issue of the patent.

SOUTH AMERICAN REPUBLICS.—Patents are issued by all the South American republics. The principal countries in which patent protection is sought are Brazil, in which the laws are quite favorable to foreigners, Chile and Argentina. Patents are also frequently secured in Venezuela, Peru, Ecuador, Colombia and Paraguay, but only for certain classes of invention, owing to the expense involved in procuring the patents.

SOUTH AFRICA.—Patents are obtainable in four important states, Cape Colony, Transvaal, Congo Free State and Orange Free State.

JAPAN has recently enacted a system of patent laws on a liberal basis.

CHINA has no patent laws nor patent office.

The conditions under which foreigners may file applications in the countries having patent laws vary greatly, and no attempt has been made to specify under what conditions applications may be filed. In most countries, however, the issuance of a prior foreign patent will either defeat the issuance of the patent subsequently applied for in another country, or will render the patent invalid even if it is issued. Great care should be taken, therefore, to avoid having a foreign patent issue at such a time as to endanger the life of the patent at home. The many dangers and difficulties which have arisen from the differing laws and the varying practice in different countries have led to the establishment of rectifying provisions which lessen these various disparities and rendering them innocuous.

—*Encyclopedia Americana.*

PATENT LAWS OF THE UNITED STATES.

[The Constitutional Provision.—The Congress shall have power * * * to promote the progress of Science and Useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.]

STATUTES.

ORGANIZATION OF THE PATENT OFFICE.

TITLE XI, Rev. Stat., p. 80:

Sec. 475. There shall be in the Department of the Interior an office known as the Patent Office, where all records, books, models, drawings, specifications, and other papers and things pertaining to patents shall be safely kept and preserved.

Sec. 476. There shall be in the Patent Office a Commissioner of Patents, one Assistant Commissioner, and three examiners-in-chief, who shall be appointed by the President, by and with the advice and consent of the Senate. All other officers, clerks, and employees authorized by law for the

Office shall be appointed by the Secretary of the Interior, upon the nomination of the Commissioner of Patents.

COURTS.

Sec. 629. The circuit courts shall have original jurisdiction * * * of all suits at law or in equity arising under the patent copyright laws of the United States.

TITLE XIII, Rev. Stat., p. 169:

Sec. 893. Copies of the specifications and drawings of foreign letters patent certified as provided in the preceding section, shall be prima facie evidence of the fact of the granting of such letters patent, and of the date and contents thereof.

Sec. 894. The printed copies of specifications and drawings of patents, which the Commissioner of Patents is authorized to print for gratuitous distribution, and to deposit in the capitols of the States and Territories, and in the clerks' offices of the district courts, shall, when certified by him and authenticated by the seal of his office, be received in all courts as evidence of all matters therein contained.

Sec. 1537. No patented article connected with marine engines shall hereafter be purchased or used in connection with any steam vessels of war until the same shall have been submitted to a competent board of naval engineers, and recommended by such board, in writing, for purchase and use.

TITLE XVII, Rev. Stat., p. 292:

Sec. 1673. No royalty shall be paid by the United States to any one of its officers or employees for the use of any patent for the system, or any part theeof, mentioned in the preceding section. nor for any such patent in which said officers or employees may be directly or indirectly interested.

PATENTS.

TITLE LX, Rev. Stat., 1878, chap. 1, p. 945:

Sec. 4883. All patents shall be issued in the name of the United States of America, under the seal of the Patent Office, and shall be signed by the Commissioner of Patents, and they shall be recorded, together with the specifications, in the Patent Office in books to be kept for that purpose.

Sec. 4884. Every patent shall contain a short title or description of the invention or discovery, correctly indicating its nature and design, and a grant to the patentee, his heirs or assigns, for the term of seventeen years, of the exclusive right to make, use, and vend the invention or discovery throughout the United States and the Territories thereof, referring to the specification for the particulars thereof. A copy of the specification and drawings shall be annexed to the patent and be a part thereof.

Sec. 4885. Every patent shall bear date as of a day not later than six months from the time at which it was passed and allowed and notice thereof was sent to the applicant or his agent; and if the final fee is not paid within that period the patent shall be withheld.

Sec. 4886. Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, not known or used by others in this country, before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor.

The Secretary of the Interior and the Commissioner of Patents are authorized to grant any officer of the Government, except officers and employees of the Patent Office, a patent for any invention of the classes mentioned in section 4886 of the Revised Statutes when such invention is used or to be used in the public service, without the payment of any fee: *Provided*, That the applicant in his application shall state that the invention described therein, if patented, may be used by the Government, or any of its officers or employees in prosecution of work for the Government, or by any other person in the United States, without the payment to him of any royalty thereon, which stipulation shall be included in the patent.

Sec. 4887. No person otherwise entitled thereto shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid by reason of its having been first patented or caused to be patented by the inventor or his legal representatives or assigns in a foreign

country, unless the application for said foreign patent was filed more than twelve months, in cases within the provisions of section 4886 of the Revised Statutes, and four months in cases of designs, prior to the filing of the application in this country, in which case no patent shall be granted in this country.

An application for patent for an invention or discovery or for a design filed in this country by any person who has previously regularly filed an application for a patent for the same invention, discovery, or design in a foreign country which, by treaty, convention, or law, affords similar privileges to citizens of the United States shall have the same force and effect as the same application would have if filed in this country on the date on which the application for patent for the same invention, discovery, or design was first filed in such foreign country, provided the application in this country is filed within twelve months in cases within the provisions of section 4886 of the Revised Statutes, and within four months in cases of designs, from the earliest date on which any such foreign application was filed. But no patent shall be granted on an application for patent for an invention or discovery or a design which had been patented or described in a printed publication in this or any foreign country more than two years before the date of the actual filing of the application in this country, or which had been in public use or on sale in this country for more than two years prior to such filing.

Sec. 4888. Before any inventor or discoverer shall receive a patent for his invention or discovery, he shall make application therefor, in writing, to the Commissioner of Patents, and shall file in the Patent Office a written description of the same, and of the manner and process of making, constructing, compounding, and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same; and in case of a machine, he shall explain the principle thereof, and the best mode in which he has contemplated applying that principle, so as to distinguish it from other inventions; and he shall particularly point out and distinctly claim the part, improvement, or combination which he claims as his invention or discovery. The specification and claim shall be signed by the inventor and attested by two witnesses.

Sec. 4889. When the nature of the case admits of drawings, the applicant shall furnish one copy signed by the inventor or his attorney in fact, and attested by two witnesses, which shall be filed in the Patent Office; and a copy of the drawing, to be furnished by the Patent Office, shall be attached to the patent as a part of the specification.

Sec. 4890. When the invention or discovery is of a composition of matter, the applicant, if required by the Commissioner, shall furnish specimens of ingredients and of the composition, sufficient in quantity for the purpose of experiment.

Sec. 4891. In all cases which admit of representation by model, the applicant, if required by the Commissioner, shall furnish a model of convenient size to exhibit advantageously the several parts of his invention or discovery.

Sec. 4892. The applicant shall make oath that he does verily believe himself to be the original and first inventor or discoverer of the art, machine, manufacture, composition, or improvement for which he solicits a patent; that he does not know and does not believe that the same was ever before known or used; and shall state of what country he is a citizen. Such oath may be made before any person within the United States authorized by law to administer oaths, or, when the applicant resides in a forengn country, before any minister, charge d'affaires, consul, or commercial agent holding commission under the Government of the United States, or before any notary public, judge, or magistrate having an official seal and authorized to administer oaths in the foreign country in which the applicant may be, whose authority shall be proved by certificate of a diplomatic or consular officer of the United States.

Sec. 4893. On the filing of any such application and the payment of the fees required by law, the Commissioner of Patents shall cause an examination to be made of the alleged new invention or discovery; and if on such examination it shall appear that the claimant is justly entitled to a patent under the law, and that the same is sufficiently useful and important, the

Commissioner shall issue a patent therefor.

Sec. 4894. All applications for patents shall be completed and prepared for examination within one year after the filing of the application, and in default thereof, or upon failure of the applicant to prosecute the same within one year after any action therein, of which notice shall have been given to the applicant, they shall be regarded as abandoned by the parties thereto, unless it be shown to the satisfaction of the Commissioner of Patents that such delay was unavoidable.

Sec. 4895. Patents may be granted and issued or reissued to the assignee of the inventor or discoverer; but the assignment must first be entered of record in the Patent Office. And in all cases of an application by an assignee for the issue of a patent, the application shall be made and the specification sworn to by the inventor or discoverer; and in all cases of an application for a reissue of any patent, the application must be made and the corrected specification signed by the inventor or discoverer, if he is living, unless the patent was issued and the assignment made before the eighth day of July, 1870.

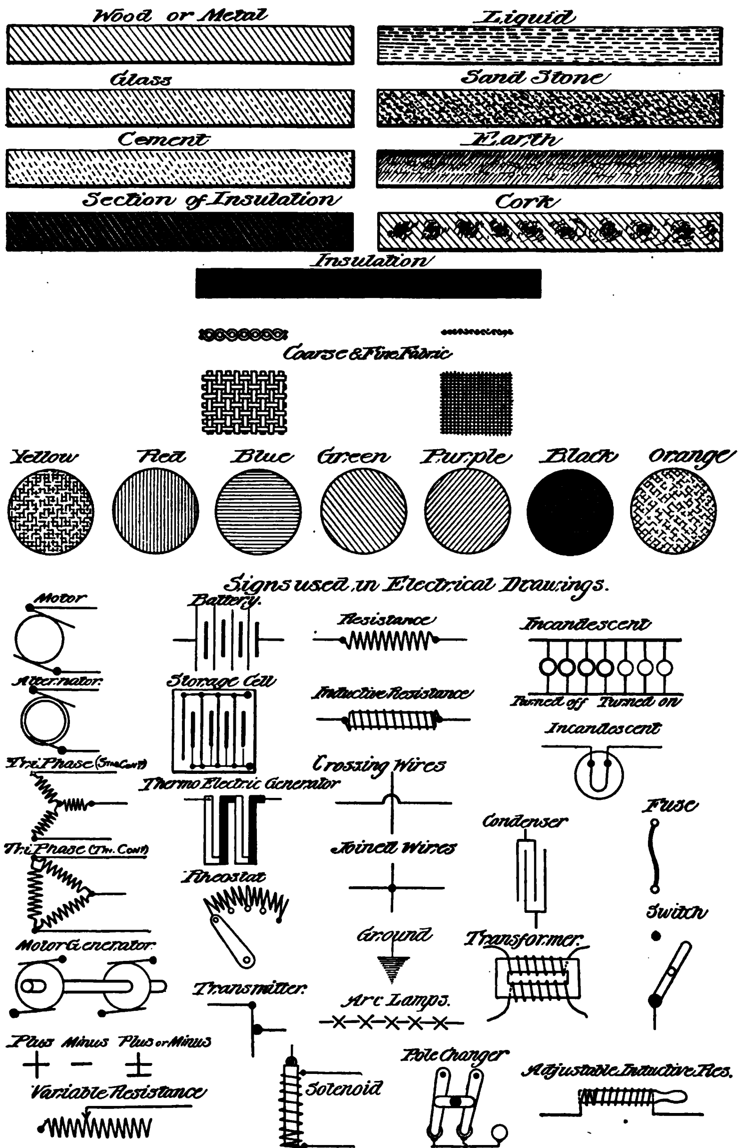
Sec. 4896. When any person, having made any new invention or discovery for which a patent might have been granted, dies before a patent is granted, the right of applying for and obtaining the patent shall devolve on his executor or administrator, in trust for the heirs at law of the deceased, in case he shall have died intestate; or if he shall have left a will disposing of the same, then in trust for his devisees, in as full manner and on the same terms and conditions as the same might have been claimed or enjoyed by him in his lifetime; and when the application is made by such legal representatives, the oath or affirmation required to be made shall be so varied in form that it can be made by them. The executor or administrator duly authorized under the law of any foreign country to administer upon the estate of the deceased inventor shall, in case the said inventor was not domiciled in the United States at the time of his death, have the right to apply for and obtain the patent. The authority of such foreign executor or administrator shall be proved by certificate of a diplomatic or consular officer of the United States.

Sec. 4897. Any person who has an interest in an invention or discovery, whether as inventor, discoverer, or assignee, for which a patent was ordered to issue upon the payment of the final fee, but who fails to make payment thereof within six months from the time at which it was passed and allowed, and notice thereof was sent to the applicant or his agent, shall have a right to make an application for a patent for such invention or discovery the same as in the case of an original application. But such second application must be made within two years after the allowance of the original application. But no person shall be held responsible in damages for the manufacture or use of any article or thing for which a patent was ordered to issue under such renewed application prior to the issue of the patent. And upon the hearing of renewed applications preferred under this section, abandonment shall be considered as a question of fact.

Sec. 4898. Every patent or any interest therein shall be assignable in law by an instrument in writing, and the patentee or his assigns or legal representatives may in like manner grant and convey an exclusive right under his patent to the whole or any specified part of the United States. An assignment, grant, or conveyance shall be void as against any subsequent purchaser for mortgagee or a valuable consideration, without notice, unless it is recorded in the Patent Office within three months from the date thereof.

If any such assignment, grant, or conveyance of any patent shall be acknowledged before any notary public of the several States or Territories or the District of Columbia, or any commissioner of the United States Circuit Court, or before any secretary of legation or consular officer authorized to administer oaths or perform notarial acts under section 1750 of the Revised Statutes, the certificate of such acknowledgment, under the hand and official seal of such notary or other officer, shall be prima facie evidence of the execution of such assignment, grant or conveyance.

Sec. 4899. Every person who purchases of the inventor or discoverer, or, with his knowledge and consent, constructs any newly invented or discovered machine, or other patentable article, prior to the application by the inventor or discoverer for a patent, or who sells or uses one so constructed, shall have the right to use, and vend



CONVENTIONAL SIGNS USED IN U. S. PATENT OFFICE DRAWINGS.

to others to be used, the specific thing so made or purchased, without liability therefor.

Sec. 4900. It shall be the duty of all patentees, and their assigns and legal representatives, and of all persons making or vending any patented article for or under them, to give sufficient notice to the public that the same is patented either by fixing thereon the word "patented," together with the day and year the patent was granted; or when, from the character of the article, this cannot be done, by fixing to it, or to the package wherein one or more of them is inclosed, a label containing the like notice; and in any suit for infringement, by the party failing so to mark, no damages shall be recovered by the plaintiff, except on proof that the defendant was duly notified of the infringement, and continued, after such notice, to make, use, or vend the article so patented.

Sec. 4901. Every person who, in any manner, marks upon anything made, used, or sold by him for which he has not obtained a patent, the name or any imitation of the name of any persons who has obtained a patent therefor, without the consent of such patentee, or his assigns or legal representatives; or

Who, in any manner, marks upon or affixes to any such patented article the word "patent" or "patentee," or the words "letters patent," or any word of like import, with intent to imitate or counterfeit the mark or device of the patentee, without having the license or consent of such patentee or his assigns or legal representatives; or

Who, in any manner, marks upon or affixes to any unpatented article the word "patent" or any word importing that the same is patented, for the purpose of deceiving the public, shall be liable, for every such offense, to a penalty of not less than one hundred dollars, with costs; one-half of said penalty to the person who shall sue for the same, and the other to the use of the United States, to be recovered by suit in any district court of the United States within whose jurisdiction such offense may have been committed.

Sec. 4902. Any person who makes any new invention or discovery and desires further time to mature the same may, on payment of the fees required by law, file in the Patent Office a caveat setting forth the design thereof and of its distinguishing characteristics and praying protection of his right until he shall have matured his invention. Such caveat shall be filed in the confidential archives of the office and preserved in secrecy, and shall be operative for the term of one year from the filing thereof; and if application is made within the year by any other persons for a patent with which such caveat would in any manner interfere the Commissioner shall deposit the description, specification, drawings, and model of such application in like manner in the confidential archives of the office, and give notice thereof by mail to the person by whom the caveat was filed. If such person desires to avail himself of his caveat he shall file his description, specifications, drawings, and model within three months from the time of placing the notice in the post-office in Washington, with the usual time required for transmitting it to the caveator added thereto, which time shall be indorsed on the notice.

Sec. 4903. Whenever, on examination, any claim for a patent is rejected, the Commissioner shall notify the applicant thereof, giving him briefly the reasons for such rejection, together with such information and references as may be useful in judging of the propriety of renewing his application or of altering his specification; and if, after receiving such notice, the applicant persists in his claim for a patent, with or without altering his specifications, the Commissioner shall order a re-examination of the case.

Sec. 4904. Whenever an application is made for a patent which, in the opinion of the Commissioner, would interfere with any pending application, or with any unexpired patent, he shall give notice thereof to the applicants, or applicant and patentee, as the case may be, and shall direct the primary examiner to proceed to determine the question of priority of invention. And the Commissioner may issue a patent to the party who is adjudged the prior inventor, unless the adverse party appeals from the decision of the primary examiner, or of the board of examiners-in-chief, as the case may be, within such time, not less than twenty days, as the Commissioner shall prescribe.

Sec. 4905. The Commissioner of Patents may establish rules for taking affidavits and depositions required in cases pending in the Patent Office, and such affidavits and depositions may be

taken before any officer authorized by law to take depositions to be used in the courts of the United States or of the State where the officer resides.

Sec. 4906. The clerk of any court of the United States, for any district or Territory wherein testimony is to be taken for use in any contested case pending in the Patent Office, shall, upon the application of any party thereto, or of his agent or attorney, issue a subpœna for any witness residing or being within such district or Territory, commanding him to appear and testify before any officer in such district or Territory authorized to take depositions and affidavits, at any time and place in the subpœna stated. But no witness shall be required to attend at any place more than forty miles from the place where the subpœna is served upon him.

Sec. 4907. Every witness duly subpœnaed and in attendance shall be allowed the same fees as are allowed to witnesses attending the courts of the United States.

Sec. 4908. Whenever any witness, after being duly served with such subpœna, neglects or refuses to appear, or after appearing refuses to testify, the judge of the court whose clerk issued the subpœna may, on proof of such neglect or refusal, enforce obedience to the process, or punish the disobedience, as in other like cases. But no witness shall be deemed guilty of contempt for disobeying such subpœna, unless his fees and traveling expenses in going to, returning from, and one day's attendance at the place of examination, are paid or tendered him at the time of the service of the subpœna; nor for refusing to disclose any secret invention or discovery made or owned by himself.

Sec. 4909. Every applicant for a patent or for the reissue of a patent, any of the claims of which have been twice rejected, and every party to an interference, may appeal from the decision of the primary examiner, or of the examiner in charge of interferences in such case, to the board of examiners-in-chief; having once paid the fee for such appeal.

Sec. 4910. If such party is dissatisfied with the decision of the examiners-in-chief, he may, on payment of the fee prescribed, appeal to the Commissioner in person.

Sec. 4911. If such party, except a party to an interference, is dissatisfied with the decision of the Commissioner, he may appeal to the Supreme Court of the District of Columbia, sitting in banc.

Sec. 4912. When an appeal is taken to the Supreme Court of the District of Columbia, the appellant shall give notice thereof to the Commissioner, and file in the Patent Office within such time as the Commissioner shall appoint, his reasons of appeal. specifically set forth in writing.

Sec. 4913. The court shall, before hearing such appeal, give notice to the Commissioner of the time and place of the hearing, and on receiving such notice the Commissioner shall give notice of such time and place in such manner as the court may prescribe, to all parties who appear to be interested therein. The party appealing shall lay before the court certified copies of all the original papers and evidence in the case, and the Commissioner shall furnish the court with the grounds of his decision, fully set forth in writing, touching all the points involved by the reasons of appeal. And at the request of any party interested, or of the court, the Commissioner and the examiners may be examined under oath, in explanation of the principles of the thing for which a patent is demanded.

Sec. 4914. The court, on petition, shall hear and determine such appeal, and revise the decision appealed from in a summary way, on the evidence produced before the Commissioner, at such early and convenient time as the court may appoint; and the revision shall be confined to the points set forth in the reasons of appeal. After hearing the case the court shall return to the Commissioner a certificate of its proceedings and decision, which shall be entered of record in the Patent Office, and shall govern the further proceedings in the case. But no opinion or decision of the court in any such case shall preclude any person interested from the right to contest the validity of such patent in any court wherein the same may be called in question.

Sec. 4915. Whenever a patent on application is refused, either by the Commissioner of Patents or by the Supreme Court of the District of Columbia upon appeal from the Commissioner, the applicant may have remedy by bill in equity; and the court having cognizance thereof, on notice to adverse parties and other due proceedings had, may adjudge that such applicant is entitled, according to law, to receive a patent for his invention, as specified in his claim, or for

any part thereof, as the facts in the case may appear. And such adjudication, if it be in favor of the right of the applicant, shall authorize the Commissioner to issue such patent on the applicant filing in the Patent Office a copy of the adjudication, and otherwise complying with the requirements of law. In all cases where there is no opposing party, a copy of the bill shall be served on the Commissioner; and all the expenses of the proceeding shall be paid by the applicant, whether the final decision is in his favor or not.

R. S., U. S., Sup., Vol. 2, c. 74, Feb. 9, 1893. *Be it enacted, etc.*, That there shall be, and there is hereby, established in the District of Columbia a court, to be known as the court of appeals of the District of Columbia.

Sec. 6. That the said court of appeals shall establish a term of the court during each and every month in each year excepting the months of July and August.

Sec. 8. That any final judgment or decree of the said court of appeals may be re-examined and affirmed, reversed, or modified by the Supreme Court of the United States, upon writ of error or appeal, in all causes in which the matter in dispute, exclusive of costs, shall exceed the sum of five thousand dollars, in the same manner and under the same regulations as heretofore provided for in cases of writs of error on judgment or appeals from decrees rendered in the supreme court of the District of Columbia;

And also in cases, without regard to the sum or value of the matter in dispute, wherein is involved the validity of any patent or copyright, or in which is drawn in question the validity of a treaty or statute of or an authority exercised under the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in any case heretofore made final in the court of appeals of the District of Columbia it shall be competent for the Supreme Court to require, by certiorari or otherwise, any such case to be certified to the Supreme Court for its review and determination, with the same power and authority in the case as if it had been carried by appeal or writ of error to the Supreme Court.

Sec. 9. That the determination of appeals from the decision of the Commissioner of Patents, now vested in the general term of the supreme court of the District of Columbia, in pursuance of the provisions of section 780 of the Revised Statutes of the United States, relating to the District of Columbia, shall hereafter be and the same is hereby vested in the court of appeals created by this act;

And in addition, any party aggrieved by a decision of the Commissioner of Patents in any interference case may appeal therefrom to said court of appeals.

TITLE LX, Rev. Stat., 1878, p. 950:

Sec. 4916. Whenever any patent is inoperative or invalid, by reason of a defective or insufficient specification, or by reason of the patentee claiming as his own invention or discovery more than he had a right to claim as new, if the error has arisen by inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, the Commissioner shall, on the surrender of such patent and the payment of the duty required by law, cause a new patent for the same invention, and in accordance with the corrected specification, to be issued to the patentee, or, in case of his death or of an assignment of the whole or any undivided part of the original patent, then to his executors, administrators, or assigns, for the unexpired part of the term of the original patent. Such surrender shall take effect upon the issue of the amended patent. The Commissioner may, in his discretion, cause several patents to be issued for distinct and separate parts of the thing patented, upon demand of the applicant, and upon payment of the required fee for a reissue for each of such reissued letters patent. The specifications and claim in every such case shall be subject to revision and restriction in the same manner as original applications are. Every patent so reissued, together with the corrected specifications, shall have the same effect and operation in law, on the trial of all actions for causes thereafter arising, as if the same had been originally filed in such corrected form; but no new matter shall be introduced into the specification, nor in case of a machine patent shall the model or drawings be amended, except each by the other; but when there is neither model nor drawing, amendments may be made upon proof satisfactory to the Commissioner that such new matter or amendment was a part of the original invention, and was omitted from the specification by inad-

vertence, accident, or mistake, as aforesaid.

Sec. 4917. Whenever, through inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, a patentee has claimed more than that of which he was the original or first inventor or discoverer, his patent shall be valid for all that part which is truly and justly his own, provided the same is a material or substantial part of the thing patented; and any such patentee, his heirs or assigns, whether of the whole or any sectional interest therein, may, on payment of the fee required by law, make disclaimer of such parts of the thing patented as he shall not choose to claim or to hold by virtue of the patent or assignment, stating therein the extent of his interest in such patent. Such disclaimer shall be in writing, attested by one or more witnesses, and recorded in the patent office; and it shall thereafter be considered as part of the original specification to the extent of the interest possessed by the claimant and by those claiming under him after the record thereof. But no such disclaimer shall affect any action pending at the time of its being filed, except so far as may relate to the question of unreasonable neglect or delay in filing it.

Sec. 4918. Whenever there are interfering patents, any person interested in any one of them, or in the working of the invention claimed under either of them, may have relief against the interfering patentee, and all parties interested under him, by suit in equity against the owners of the interfering patent; and the court, on notice to adverse parties, and other due proceedings had according to the course of equity, may adjudge and declare either of the patents void in whole or in part, or inoperative, or invalid in any particular part of the United States, according to the interest of the parties in the patent or the invention patented. But no such judgment or adjudication shall affect the right of any person except the parties to the suit and those deriving title under them subsequent to the rendition of such judgment.

Sec. 4919. Damages for the infringement of any patent may be recovered by action on the case, in the name of the party interested either as patentee, assignee, or grantee. And whenever in any such action a verdict is rendered for the plaintiff, the court may enter judgment thereon for any sum above the amount found by the verdict as the actual damages sustained, according to the circumstances of the case, not exceeding three times the amount of such verdict, together with the costs.

Sec. 4920. In any action for infringement the defendant may plead the general issue, and, having given notice in writing to the plaintiff or his attorney thirty days before, may prove on trial any one or more of the following special matters:

First.—That for the purpose of deceiving the public the description and specification filed by the patentee in the Patent Office was made to contain less than the whole truth relative to his invention or discovery, or more than is necessary to produce the desired effect; or,

Second. — That he had surreptitiously or unjustly obtained the patent for that which was in fact invented by another, who was using reasonable diligence in adapting and perfecting the same; or,

Third.—That it has been patented or described in some printed publication prior to his supposed invention or discovery thereof, or more than two years prior to his application for a patent therefor; or,

Fourth.—That he was not the original and first inventor or discoverer of any material and substantial part of the thing patented; or,

Fifth.—That it had been in public use or on sale in this country for more than two years before his application for a patent, or had been abandoned to the public.

And in notices as to proof of previous invention, knowledge, or use of the thing patented, the defendant shall state the names of the patentees and the dates of their patents, and when granted, and the names and residences of the persons alleged to have invented or to have had the prior knowledge of the thing patented, and where and by whom it had been used; and if any one or more of the special matters alleged shall be found for the defendant, judgment shall be rendered for him with costs. And the like defenses may be pleaded in any suit in equity for relief against an alleged infringement; and proofs of the same may be given upon like notice in the answer of the defendant, and with the like effect.

Sec. 4921. The several courts vested with jurisdiction of cases arising under the patent laws shall have power to grant injunctions according to

the course and principles of courts of equity, to prevent the violation of any right secured by patent, on such terms as the court may deem reasonable; and upon a decree being rendered in any such case for an infringement the complainant shall be entitled to recover. in addition to the profits to be accounted for by the defendant, the damages the complainant has sustained thereby; and the court shall assess the same or cause the same to be assessed under its direction. And the court shall have the same power to increase such damages, in its discretion, as is given to increase the damages found by verdicts in actions in the nature of actions of trespass upon the case.

But in any suit or action brought for the infringement of any patent there shall be no recovery of profits or damages for any infringement committed more than six years before the filing of the bill of complaint or the issuing of the writ in such suit or action, and this provision shall apply to existing causes of action.

Sec. 4922. Whenever, through inadvertence, accident, or mistake, and without any wilful default or intent to defraud or mislead the public, a patentee has. in his specification, claimed to be the original and first inventor or discoverer of any material or substantial part of the thing patented, of which he was not the original and first inventor or discoverer, every such patentee, his executors, administrators, and assigns, whether of the whole or any sectional interest in the patent, may maintain a suit at law or in equity, for the infringement of any part thereof, which was bona fide his own, if it is a material and substantial part of the thing patented, and definitely distinguishable from the parts claimed without right, notwithstanding the specifications may embrace more than that of which the patentee was the first inventor or discoverer. But in every such case in which a judgment or decree shall be rendered for the plaintiff, no costs shall be recovered unless the proper disclaimer has been entered at the Patent Office before the commencement of the suit. But no patentee shall be entitled to the benefits of this section if he has unreasonably neglected or delayed to enter a disclaimer.

Sec. 4923. Whenever it appears that a patentee, at the time of making his application for the patent, believed himself to be the original and first inventor or discoverer of the thing patented, the same shall not be held to be void on account of the invention or discovery, or any part thereof, having been known or used in a foreign country, before his invention or discovery thereof, if it had not been patented or described in a printed publication.

DESIGNS.

Sec. 4929. Any person who has invented any new, original, and ornamental design for an article of manufacture, not known or used by others in this country before his invention thereof, and not patented or described in any printed publication in this or any foreign country before his invention thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law and other due proceedings had. the same as in cases of invention or discoveries covered by section 4886, obtain a patent therefor.

Sec. 4930. The Commissioner may dispense with models of designs when the design can be sufficiently represented by drawings or photographs.

Sec. 4931. Patents for designs may be granted for the term of three years and six months, or for seven years, or for fourteen years, as the applicant may, in his application, elect.

Sec. 4932. Patentees of designs issued prior to the second day of March. 1861, shall be entitled to extension of their respective patents for the term of seven years, in the same manner and under the same restrictions as are provided for the extension of patents for inventions or discoveries issued prior to the second day of March, 1861.

Sec. 4933. All the regulations and provisions which apply to obtaining or protecting patents for inventions or discoveries not inconsistent with the provisions of this Title, shall apply to patents for designs.

CHAPTER 105.—An Act to Amend the Law Relating to Patents, Trade-marks, and Copyrights.

Be it enacted, etc., That hereafter, during the term of letters patent for a design, it shall be unlawful for any person other than the owner of said letters patent, without the license of such owner, to apply the design se-

cured by such letters patent, or any colorable imitation thereof, to any article of manufacture for the purpose of sale, or to sell or expose for sale any article of manufacture to which such design or colorable imitation shall, without the license of the owner, have been applied, knowing that the same has been so applied. Any person violating the provisions, or either of them, of this section, shall be liable in the amount of two hundred and fifty dollars; and in case the total profit made by him from the manufacture or sale, as aforesaid, of the article or articles to which the design, or colorable imitation thereof, has been applied, exceeds the sum of two hundred and fifty dollars, he shall be further liable for the excess of such profit over and above the sum of two hundred and fifty dollars; and the full amount of such liability may be recovered by the owner of the letters patent, to his own use, in any circuit court of the United States having jurisdiction of the parties, either by action at law or upon a bill in equity for an injunction to restrain such infringement.

Sec. 2. That nothing in this act contained shall prevent, lessen, impeach, or avoid any remedy at law or in equity which any owner of letters patent for a design, aggrieved by the infringement of the same, might have had if this act had not been passed; but such owner shall not twice recover the profit made from the infringement.

FEES.

Sec. 4934. The following shall be the rates for patent fees: On filing each original application for a patent, except in design cases, $15.00. On issuing each original patent, except in design cases, $20.00. In design cases: For three years and six months; $10.00; for seven years, $15.00; for fourteen years, $30.00. On filing each caveat, $10.00. On every application for the reissue of a patent, $30.00. On filing each disclaimer, $10.00. On an appeal for the first time from the primary examiners to the examiners-in-chief, $10.00. On every appeal from the examiners-in-chief to the Commissioner, $20.00. For certified copies of patents and other papers, including certified printed copies, 10 cents per hundred words. For recording every assignment, agreement, power of attorney, or other paper, of three hundred words or under, $1.00; of over three hundred and under one thousand words, $2.00; of over one thousand words, $3.00. For copies of drawings, the reasonable cost of making them.

Sec. 4935. Patent fees may be paid to the Commissioner of Patents, or to the Treasurer, or any of the assistant treasurers of the United States, or to any of the designated depositaries, national banks, or receivers of public money, designated by the Secretary of the Treasury for that purpose; and such officer shall give the depositor a receipt or certificate of deposit therefor. All money received at the Patent Office, for any purpose, or from any source whatever, shall be paid into the Treasury as received, without any deduction whatever.

Sec. 4936. The Treasurer of the United States is authorized to pay back any sum or sums of money to any person who has through mistake paid the same into the Treasury, or to any receiver or depositary, to the credit of the Treasury, as for fees accruing at the Patent Office, upon a certificate thereof being made to the Treasurer by the Commissioner of Patents.

PATENT RIGHTS VEST IN ASSIGNEE IN BANKRUPTCY.

Sec. 5046. All property conveyed by the bankrupt in fraud of his creditors; all rights in equity, choses in action, patent rights, and copyrights; all debts due him, or any person for his use, and all liens and securities therefor; and all his rights of action for property or estate, real or personal, and for any cause of action which he had against any person arising from contract or from the unlawful taking or detention, or injury to the property of the bankrupt; and all his rights of redeeming such property or estate; together with the like right, title, power, and authority to sell, manage, dispose of, sue for, and recover or defend the same, as the bankrupt might have had if no assignment had been made, shall, in virtue of the adjudication of bankruptcy and the appointment of his assignee, but subject to the exceptions stated in the preceding section, be at once vested is [in] such assignee.

Sec. 70. Title to Property. The trustee of the estate of a bankrupt, upon his appointment and qualification, and his successor or successors, if he shall have one or more, upon his or their appointment and qualification, shall in turn be vested by operation of law with the

title of the bankrupt, as of the date he was adjudged a bankrupt, except in so far as it is to property which is exempt, to all (1) documents relating to his property; (2) interests in patents, patent rights, copyrights, and trade-marks.

LABELS.

CHAPTER 301.—An Act to Amend the Law Relating to Patents, Trade-marks, and Copyrights.

Be it enacted, etc. [Section 1], That no person shall maintain an action for the infringement of his copyright unless he shall give notice thereof by inserting in the several copies of every edition published, on the title page or the page immediately following it, if it be a book; or if a map, chart, musical composition, print, cut, engraving, photograph, painting, drawing, chromo, statue, statuary, or model or design intended to be perfected and completed as a work of the fine arts, by inscribing upon some visible portion thereof, or of the substance on which the same shall be mounted, the following words, viz.: "Entered according to act of Congress, in the year ——, by A. B., in the office of the Librarian of Congress, at Washington"; or, at his option, the word "Copyright," together with the year the copyright was entered, and the name of the party by whom it was taken out, thus: "Copyright, 18—, by A. B."

Sec. 2. That for recording and certifying any instrument of writing for the assignment of a copyright, the Librarian of Congress shall receive from the persons to whom the service is rendered, $1.00; and for every copy of an assignment, $1.00; said fee to cover, in either case, a certificate of the record, under seal of the Librarian of Congress; and all fees so received shall be paid into the Treasury of the United States.

Sec. 3. That in the construction of this act, the words "engraving," "cut," and "print," shall be applied only to pictorial illustrations or works connected with the fine arts, and no prints or labels designed to be used for any other articles of manufacture shall be entered under the copyright law, but may be registered in the Patent Office. And the Commissioner of Patents is hereby charged with the supervision and control of the entry or registry of such prints or labels, in conformity with the regulations provided by law as to copyright of prints, except that there shall be paid for recording the title of any print or label not a trade-mark, $6.00, which shall cover the expense of furnishing a copy of the record under the seal of Commissioner of Patents, to the party entering the same.

Sec. 4. That all laws and parts of laws inconsistent with the foregoing provisions be, and the same are hereby repealed.

Sec. 5. That this act shall take effect on and after the first day of August, 1874.

TRADE-MARKS.

[*The Constitutional Provision.*—The Congress shall have power * * * (3) to regulate commerce with foreign nations, and among the several States, and with the Indian tribes. Art. I, sec. 8.]

THE STATUTE OF 1876.

CHAPTER 274.—An Act to Punish the Counterfeiting of Trade-Mark Goods and the Sale or Dealing in of Counterfeit Trade-Mark Goods.

Be it enacted, etc. [Section 1], That every person who shall, with intent to defraud, deal in or sell, or keep or offer for sale, or cause or procure the sale of, any goods of substantially the same descriptive properties as those referred to in the registration of any trade-mark, pursuant to the statutes of the United States, to which, or to the package in which the same are put up, is fraudulently affixed said trade-mark, or any colorable imitation thereof, calculated to deceive the public, knowing the same to be counterfeit or not the genuine goods referred to in said registration, shall, on conviction thereof, be punished by fine not exceeding $1,000 dollars, or imprisonment not more than two years, or both such fine and imprisonment.

Sec. 2. That every person who fraudulently affixes, or causes or procures to be fraudulently affixed, any trade-mark registered pursuant to the statutes of the United States, or any colorable imitation thereof, calculated to deceive the public, to any goods, of substantially the same descriptive properties as those referred to in said registration, or to the package in which they are put up, knowing the same to be counterfeit, or not the genuine goods, referred to in said registration, shall, on conviction thereof, be punished as prescribed in the first section of this act.

Sec. 3. That every person who fraudulently fills, or causes or pro-

cures to be fraudulently filled, any package to which is affixed any trade-mark, registered pursuant to the statutes of the United States, or any colorable imitation thereof, calculated to deceive the public, with any goods of substantially the same descriptive properties as those referred to in said registration, knowing the same to be counterfeit, or not the genuine goods referred to in said registration, shall, on conviction thereof, be punished as prescribed in the first section of this act.

Sec. 4. That any person or persons who shall, with intent to defraud any person or persons, knowingly and wilfully cast, engrave, or manufacture, or have in his, her, or their possession, or buy, sell, offer for sale, or deal in, any die or dies, plate or plates, brand or brands, engraving or engravings, on wood, stone, metal, or other substance, moulds, or any false representation, likeness, copy, or colorable imitation of any die plate, brand, engraving, or mould of any private label, brand, stamp, wrapper, engraving on paper or other substance, or trade-mark, registered pursuant to the statutes of the United States, shall, upon conviction thereof, be punished as prescribed in the first section of this act.

Sec. 5. That any person or persons who shall, with intent to defraud any person or persons, knowingly and wilfully make, forge, or counterfeit, or have in his, her, or their possession, or buy, sell, offer for sale or deal in, any representation, likeness, similitude, copy, or colorable imitation of any private label, brand, stamp, wrapper, engraving, mould, or trade-mark, registered pursuant to the statutes of the United States, shall, upon conviction thereof, be punished as prescribed in the first section of this act.

Sec. 6. That any person who shall, with intent to injure or defraud the owner of any trade-mark, or any other person lawfully entitled to use or protect the same, buy, sell, offer for sale, deal in or have in his possession any used or empty box, envelope, wrapper, case, bottle, or other package to which is affixed, so that the same may be obliterated without substantial injury to such box or other thing aforesaid, any trade-mark, registered pursuant to the statutes of the United States, not so defaced, erased, obliterated, and destroyed as to prevent its fraudulent use, shall, on conviction thereof, be punished as prescribed in the first section of this act.

Sec. 7. That if the owner of any trade-mark, registered pursuant to the statutes of the United States, or his agent, make oath, in writing, that he has reason to believe, and does believe, that any counterfeit dies, plates, brands, engravings on wood, stone, metal, or other substance, or moulds of his said registered trade-mark, are in the possession of any person, with intent to use the same for the purpose of deception and fraud, or make such oaths that any counterfeits or colorable imitations of his said trade-mark, label, brand, stamp, wrapper, engravings on paper or other substance, or empty box, envelope, wrapper, case, bottle, or other package, to which is affixed said registered trade-mark not so defaced, erased, obliterated, and destroyed as to prevent its fraudulent use, are in the possession of any person, with intent to use the same for the purpose of deception and fraud, then the several judges of the circuit and district courts of the United States, and the commissioners of the circuit courts may, within their respective jurisdictions, proceed under the law relating to search-warrants, and may issue a search-warrant authorizing and directing the marshal of the United States for the proper district to search for and seize all said counterfeit dies, plates, brands, engravings on wood, stone, metal, or other substance, moulds, and said counterfeit trade-marks, colorable imitations thereof, labels, brands, stamps, wrappers, engravings on paper, or other substance, and said empty boxes, envelopes, wrappers, cases, bottles, or other packages that can be found; and upon satisfactory proof being made that said counterfeit dies, plates, brands, engravings on wood, stone, metal, or other substance, moulds, counterfeit trade-marks, colorable imitations thereof, labels, brands, stamps, wrappers, engravings on paper or other substance, empty boxes, envelopes, wrappers, cases, bottles, or other packages, are to be used by the holder or owner for the purposes of deception and fraud, that any of said judges shall have full power to order all said counterfeit dies, plates, brands, engravings on wood, stone, metal, or other substance, moulds, counterfeit trade-marks, colorable imitations thereof, labels, brands, stamps, wrappers, engravings on paper or other substance, empty boxes, envelopes, wrappers, cases, bottles, or other packages, to be publicly destroyed.

Sec. 8. That any person who shall, with intent to defraud any person or persons, knowingly and wilfully aid or abet in the violation of any of the provisions of this act, shall, upon conviction thereof, be punished by a fine not exceeding five hundred dollars, or imprisonment not more than one year, or both such fine and imprisonment.

[August 14, 1876.]

THE STATUTE OF 1881.

CHAPTER 138.—AN ACT TO AUTHORIZE THE REGISTRATION OF TRADE-MARKS AND PROTECT THE SAME.

Be it enacted, etc. [Section 1], That owners of trade-marks used in commerce with foreign nations or with the Indian tribes, provided such owners shall be domiciled in the United States or located in any foreign country, or tribes, which, by treaty, convention, or law, affords similar privileges to citizens of the United States, may obtain registration of such trade-marks by complying with the following requirements:

First.—By causing to be recorded in the Patent Office a statement specifying name, domicile, location, and citizenship of the party applying; the class of merchandise, and the particular description of goods comprised in such class to which the particular trade-mark has been appropriated; a description of the trade-mark itself, with facsimiles thereof, and a statement of the mode in which the same is applied and affixed to goods, and the length of time during which the trade-mark has been used.

Second.—By paying into the Treasury of the United States the sum of $25.00, and complying with such regulations as may be prescribed by the Commissioner of Patents.

Sec. 2. That the application prescribed in the foregoing section must, in order to create any right whatever in favor of the party filing it, be accompanied by a written declaration verified by the person, or by a member of a firm, or by an officer of a corporation applying, to the effect that such party has at the time a right to the use of the trade-mark sought to be registered, and that no other person, firm, or corporation has the right to such use, either in the identical form or in any such near resemblance thereto as might be calculated to deceive; that such trade-mark is used in commerce with foreign nations or Indian tribes, as above indicated; and that the description and facsimiles presented for registry truly represent the trade-mark sought to be registered.

Sec. 3. That the time of the receipt of any such application shall be noted and recorded. But no alleged trade-mark shall be registered unless the same appear to be lawfully used as such by the applicant in foreign commerce or commerce with Indian tribes, as above mentioned, or is within the provision of a treaty, convention, or declaration with a foreign power; nor which is merely the name of the applicant; nor which is identical with a registered or known trade-mark owned by another, and appropriate to the same class of merchandise, or which so nearly resembles some other person's lawful trade-mark as to be likely to cause confusion or mistake in the mind of the public, or to deceive purchasers. In an application for registration the Commissioner of Patents shall decide the presumptive lawfulness of claim to the alleged trade-mark; and in any dispute between an applicant and a previous registrant, or between applicants, he shall follow, so far as the same may be applicable, the practice of courts of equity of the United States in analogous cases.

Sec. 4. That certificates of registry of trade-marks shall be issued in the name of the United States of America, under the seal of the Department of the Interior, and shall be signed by the Commissioner of Patents, and a record thereof, together with printed copies of the specifications, shall be kept in books for that purpose. Copies of trade-marks and of statements and declarations filed therewith and certificates of registry so signed and sealed shall be evidence in any suit in which such trade-marks shall be brought in controversy.

Sec. 5. That a certificate of registry shall remain in force for thirty years from its date, except in cases where the trade-mark is claimed for and applied to articles not manufactured in this country, and in which it receives protection under the laws of a foreign country for a shorter period, in which case it shall cease to have any force in this country by virtue of this act at the time that such trade-mark ceases to be exclusive property elsewhere. At any time during the six months prior to the expiration of the term of thirty years such registration may be renewed on the same terms and for a like period.

Sec. 6. That applicants for registration under this act shall be credited for any fee or part of a fee heretofore paid into the Treasury of the United States with intent to procure protection for the same trade-mark.

Sec. 7. That registration of a trade-mark shall be *prima facie* evidence of ownership. Any person who shall reproduce, counterfeit, copy, or colorably imitate any trade-mark registered under this act and affix the same to merchandise of substantially the same descriptive properties as those described in the registration shall be liable to an action on the case for damages for the wrongful use of said trade-mark at the suit of the owner thereof; and the party aggrieved shall also have his remedy according to the course of equity to enjoin the wrongful use of such trade-mark used in foreign commerce or commerce with Indian tribes, as aforesaid, and to recover compensation therefor in any court having jurisdiction over the person guilty of such wrongful act; and courts of the United States shall have original and appellate jurisdiction in such cases without regard to the amount in controversy.

Sec. 8. That no action or suit shall be maintained under the provisions of this act in any case when the trade-mark is used in any unlawful business or upon any article injurious in itself, or which mark has been used with the design of deceiving the public in the purchase of merchandise, or under any certificate of registry fraudulently obtained.

Sec. 9. That any person who shall procure the registry of a trade-mark, or of himself as the owner of a trade-mark, or an entry respecting a trade-mark, in the office of the Commissioner of Patents, by a false or fraudulent representation or declaration, orally or in writing, or by any fraudulent means, shall be liable to pay any damages sustained in consequence thereof to the injured party, to be recovered in an action on the case.

Sec. 10. That nothing in this act shall prevent, lessen, impeach, or avoid any remedy at law or in equity which any party aggrieved by any wrongful use of any trade-mark might have had if the provisions of this act had not been passed.

Sec. 11. That nothing in this act shall be construed as unfavorably affecting a claim to a trade-mark after the term of registration shall have expired; nor to give cognizance to any court of the United States in an action or suit between citizens of the same State, unless the trade-mark in controversy is used on goods intended to be transported to a foreign country, or in lawful commercial intercourse with an Indian tribe.

Sec. 12. That the Commissioner of Patents is authorized to make rules and regulations and prescribe forms for the transfer of the right to use trade-marks and for recording such transfers in his office.

Sec. 13. That citizens and residents of this country wishing the protection of trade-marks in any foreign country the laws of which require registration here as a condition precedent to getting such protection there may register their trade-marks for that purpose as is above allowed to foreigners, and have certificate thereof from the Patent Office.

Approved, March 3, 1881.

CHAPTER 393.—AN ACT RELATING TO THE REGISTRATION OF TRADE-MARKS.

Be it enacted, etc.—That nothing contained in the law entitled "An act to authorize the registration of trade-marks and protect the same," approved March 3, 1881, shall prevent the registry of any lawful trade-mark rightfully used by the applicant in foreign commerce or commerce with Indian tribes at the time of the passage of said act. Approved, August 5, 1882.

Sec. 2496. No watches, watch-cases, watch-movements, or parts of watch-movements, or any other articles of foreign manufacture, which shall copy or simulate the name or trade-mark of any domestic manufacture [manufacturer], shall be admitted to entry at the custom-houses of the United States, unless such domestic manufacturer is the importer of the same. And in order to aid the officers of the customs in enforcing this prohibition, any domestic manufacturer who has adopted trade-marks may require his name and residence and a description of his trade-marks to be recorded in books, which shall be kept for that purpose in the Department of the Treasury, under such regulations as the Secretary of the Treasury shall prescribe, and may furnish to the Department facsimiles of such trade-marks; and thereupon the Secretary of the Treasury shall cause one or more copies of the same to be transmitted to each collector or other proper officer of the customs.

HISTORY OF THE AMERICAN PATENT SYSTEM.

The century just closed stands out pre-eminently as the century of invention. It is therefore a fitting time briefly to refer to the origin, establishment, and development of our patent system, to call to mind the debt the United States owes to inventors, and at the same time to point out the advantages that have followed the far-seeing wisdom of the framers of the Federal Constitution in incorporating in that instrument paragraph 8 of section 8 of Article I. of the Constitution, which gave to Congress the power "To promote the progress of science and the useful arts by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries."

One hundred years ago the population of the United States was less than 6,000,000, and there was not a single city within our borders having a population of 75,000. The population of New York, Philadelphia, Baltimore, and Boston was less than the present population of Minneapolis. The latter city and its sister city of St. Paul, Chicago, Omaha, and Kansas City were unknown. Not a steam propelled vessel was in use, nor was there a mile of railroad in the United States. The electric telegraph and telephone were unknown. Our exports consisted of agricultural products. There was scarcely any well-developed line of manufacture, and our wants in that line were supplied by imports. It had been the policy of England to suppress manufacturing in its colonies. In 1634 a law was passed in Virginia for the encouragement of textile manufactures, but it was promptly annulled by England. In 1731 she enacted a law prohibiting the carriage of woolen goods and hats from one colony to another. In 1750 a woollen hat factory in Massachusetts was declared to be a nuisance and suppressed. No carpets were made in the colonies until after 1776, except rag carpets. In 1800 carpets were in this country a luxury. Even up to 1850 there was not a power loom for carpet making in the United States.

What is true in the textile art is equally true of most of the other arts.

Though the country was an agricultural one, little progress had been made in the manufacture of agricultural implements. It was not until 1819 that an iron plow was produced in this country. The reaper appeared in 1833 and a successful thresher not until 1850. Up to the time of the Civil War there is no question but that the country continued to be an agricultural one. It is true that during the first sixty years of the last century our manufactures steadily and rapidly increased in kind and in extent, but our population increased even more rapidly, so that we consumed what we manufactured and were still largely dependent upon the import of manufactured articles. But in the last few years a great reversal, not only in sentiment but in conditions, has occurred; the commercial relations of the United States with the great trading nations of the world have rapidly changed, so that the excess of imports of manufactured articles has turned into an excess of exports of such articles.

One need not look far for the cause of this. It lies in the economy of manufacture arising from the use of labor-saving devices, mainly the invention of our own people, which has enabled us to compete in many lines of manufacture, notwithstanding the higher scale of wages paid in this country, with similar articles manufactured by any or all nations. To employ these devices to the best advantage requires the intelligence of the American workmen, and the result is due to the combination of witty inventions and thinking men. Witless men behind witty machines would be of no use. To the patent system more than to any other cause are we indebted for the industrial revolution of the century.

President Washington realized the importance of formulating a law to stimulate inventions, and in his first annual message to Congress, in 1790, said:

"I can not forbear intimating to you the expediency of giving effectual encouragement as well to the introduction of new and useful inventions from abroad as to the exertion of skill and genius in producing them at home."

Congress was quick to act, and on April 10, 1790, the first law upon the subject was enacted. It constituted the Secretary of State, the Secretary of War, and the Attorney-General a board to consider all applications for patents. Owing to the fires that have destroyed the early records of the Patent Office, some question has arisen

as to the number of patents issued under this act; but from the best information obtainable I place the number at fifty-seven. The first patent issued was to Samuel Hopkins, July 31, 1790, for making pot and pearl ashes.

The act of 1793 superseded the act of 1790, and remained in force as amended from time to time until the act of 1836 was passed. The act of 1793 was the only act ever passed in this country which provided for the issuance of Letters Patent without the requirement of an examination into the novelty and utility of the invention for which the patent was sought.

The act of 1836, with modifications, remained in force until the revision of the patent laws in 1870. This revision was largely a consolidation of the statutes then in force.

Under the revision of the statutes of the United States in 1874 the act of 1870 was repealed; but the revision substantially re-enacted the provisions of the act of 1870.

Under the acts of 1790 and 1793 Letters Patent were granted for a term of fourteen years. There was no provision for extension; but while the act of 1793 was in force Congress extended some thirteen patents.

The act of 1836 provided that Letters Patent should be granted for a term of fourteen years, and provision was made for an extension for a term of seven years upon due application and upon a proper showing. Until 1848 petitions for extensions were passed upon by a board consisting of the Secretary of State, the Commissioner of Patents, and the Solicitor of the Treasury. After that time power was vested solely in the Commissioner of Patents.

The patent act of March 2, 1861 (section 16), provided that all patents thereafter granted should remain in force for a term of seventeen years from the date of issue, and the extension of such patents was prohibited.

The consolidated patent act of 1870, while providing that patents should be granted for a term of seventeen years, also provided that patents granted prior to March 2, 1861, might, upon due application and a proper showing, be extended by the Commissioner of Patents for a term of seven years from the expiration of the first term.

By the revision of the patent laws in 1874 the prohibition against the extension of patents was dropped, and since that time Congress has had the power to extend Letters Patent. Congress extended five patents granted under the act of 1836, and in nine instances authorized patentees to apply to the Commissioner of Patents for extension of their patents. So far as I have been able to discover, no patent granted for a term of seventeen years has been extended by Congress.

It was not until 1842 that the statute was passed authorizing the grant of patents for designs. Under that act design patents were granted for seven years. Subsequently provisions were made for granting them for terms of three and one-half, seven, and fourteen years, at the election of the applicant.

By the act of March 2, 1861, the Board of Examiners-in-Chief was established. Prior to that time, and during the incumbency of Commissioner Holt, temporary boards of examiners to decide appeals had been appointed by him, and later on he created a permanent board of three examiners who were to decide on appeal rejected cases and submit their decisions to him for approval.

The act of 1870 made the first provision for an Assistant Commissioner and an Examiner of Interferences. Another provision in that act was the power given the Commissioner, subject to the approval of the Secretary of the Interior, to establish regulations for the conduct of proceedings in the Office.

On January 1, 1898, an act passed March 3, 1897, went into force. Some of the provisions of this act were that applications for patents should be completed and prepared for examination within one year after the filing of the application and that the applicant should prosecute the same within one year after an action thereon or it should be regarded as abandoned (prior to that time two years was the limit); that an inventor should be debarred from receiving a patent if his invention had been first patented by him or his legal representatives or assigns in a foreign country, provided the application for the foreign patent had been filed more than seven months prior to the filing of the application in this country, and that if the invention for which a patent was applied for had been patented or described in any printed publication in this or any foreign country for more than two years prior to the application a patent could not issue.

The first provision for affording accommodations for the Patent Office was in 1810, when Congress authorized the purchase of a building for the General Post-office and for the office of the Keeper of Patents. The building purchased was known as "Blodgett's Hotel," and stood on the site now occupied by the south front of the building until recently occupied by the Post-office Department, and now used by several bureaus of the Interior Department. The east end of this building was used for the records, models, etc., of the Patent Office. This building was destroyed by fire December 13, 1836. On July 4, 1836, an act was passed appropriating $108 000 for the erection of a suitable building for the accommodation of the Patent Office, and within that month the erection of the building was begun.

It was the present south front of the Patent Office, excluding the south ends of the east and west wings. The basement (which is now the first or ground floor) was to be used for storage and analogous purposes, the first or portico floor for office rooms, and the second floor was to be one large hall with galleries on either side, and to have a vaulted roof. This hall was to be used for exhibition purposes, for the display of models of patented and unpatented inventions, and also as a national gallery of the industrial arts and manufactures.

During the erection of the Patent Office building temporary quarters were provided in the City Hall. In the spring of 1840 the building was completed and the Office moved into it. The sum of $422.011.65 was expended on this building. The patented models were then classified and exhibited in suitable glass cases, while the national gallery was arranged for exhibition of models and specimens.

By the act of March 3, 1849, the Interior Department was established and the Patent Office attached thereto. This same act appropriated $50,000 out of the patent fund to begin the east or Seventh street wing, which was completed in 1852 at a cost of $600,000, $250,000 of which was taken from the revenue of the Patent Office. In 1852 the plans for the entire building, as it now stands, were prepared. The west wing was completed in 1856 and cost $750,000. Work on the north or G street wing was begun the same year. In 1867 this wing was finished at a cost of $575.000. The entire building cost $2,347,011.65.

Since July 28, 1836, 667,173 patents for inventions, and since 1842 34,018 patents for designs have been issued by this office. Many of these patents are for minor improvements, but among them may be found a very large number covering the most remarkable and valuable inventions, which have added untold sums to the world's wealth, revolutionized the old arts, created new ones, brought oldtime luxuries within the reach of all, and made life doubly worth living. These contributions have come from men and women, white and colored. To many inventors more than a hundred patents have been issued. The following are some of the inventors who have received more than that number between 1872 and 1900, both years inclusive:

Thomas A. Edison	742
Francis H. Richards	619
Elihu Thomson	444
Charles E. Scribner	374
Luther C. Crowell	293
Edward Weston	280
Rudolph M. Hunter	276
Charles J. Van Depoele (deceased)	245
George Westinghouse	239
John W. Hyatt	209
Freeborn F. Raymond, 2d	182
Sydney H. Short	178
Rudolf Eickemeyer (deceased)	171
Milo G. Kellogg	159
Walter Scott	156
Arthur J. Moxham	150
Cyrus W. Saladee	148
Louis Goddu	146
Hiram S. Maxim	146
George D. Burton	144
Lewis H. Nash	142
Edwin Norton	141
Abbot Augustus Low	137
Philip Diehl	137
James C. Anderson	135
Edward J. Brooks	133
Elmer A. Sperry	132
Peter K. Dederick	128
Hosea W. Libbey	127
James F. McElroy	121
William N. Whiteley	121
Horace Wyman	118
Frank Rhind	117
Louis K. Johnson	114
Warren H. Taylor	112
James M. Dodge	111
George H. Reynolds	110
Talbot C. Dexter	109
James H. Northrop	102

From 1790 to March 1, 1895, some 5,535 patents were granted to wom-

en. It is a fair estimate that out of every 1,000 patents one is granted to a woman. As a rule women take out but one patent, although there are many exceptions. While the majority of patents granted them are for improvements in wearing apparel and in articles for household use, they have invented and received patents for adding machines, windmills, horseshoes, agricultural implements, and fire escapes.

To some 165 colored inventors about 400 patents have been issued. Twenty-eight patents have been issued to one and to another 22. So far as the records show, Henry Blair, of Maryland, was the first colored patentee. In 1834 he received a patent for a corn planter, and in 1836 one for a cotton planter. The character of their inventions follows lines suggested by their employment. Employed in the field and in the house, improvements in agricultural implements and articles of domestic use predominate. The sphere of their inventive effort has widened with the added opportunities afforded them to engage in mechanical vocations. They have made contributions to the electric arts and steam engineering, and many improvements in railway appliances and paper-bag machines. Before the Civil War the master of a slave living in Mississippi made application for a patent, but the Attorney-General held in an opinion reported in vol. 9, Attorney-General's Opinions, page 171, that an invention of a slave, though it be new and useful, could not be patented.

In May, 1802, President Jefferson appointed Dr. William Thornton as a clerk at $1,400 per year, to have charge of the issuance of patents. He took the title of Superintendent, and continued to act in that capacity until his death, March 28, 1828. He was succeeded by Dr. William P. Jones, who acted until his removal in the early part of President Jackson's administration. John D. Craig followed Dr. Jones, and in 1834 he was succeeded by B. F. Pickett, who served but a brief period. The last Superintendent was Henry L. Ellsworth, who became the first Commissioner under the act of 1836, and served until 1845. The other Commissioners under that act were:

Edmund Burke, May 4, 1845.
Thomas Ewbank, May 9, 1849.
Silas H. Hodges, November 8, 1852.
Charles Mason, May 16, 1853.
Joseph Holt, September 10, 1857.
William D. Bishop, May 27, 1859.
Philip F. Thomas, February 16, 1860.
D. P. Holloway, March 28, 1861.
T. C. Theaker, August 17, 1865.
Elisha Foote, July 29, 1868.
Samuel S. Fisher, April 26, 1869.

Commissioner Fisher continued as Commissioner for a short time under the act of 1870. Other Commissioners under that act have been:

M. D. Leggett, January 16, 1871.
John M. Thacher, November 4, 1874.
R. H. Duell, October 1, 1875.
Ellis Spear, January 30, 1877.
H. E. Paine, November 1, 1878.
E. M. Marble, May 7, 1880.
Benjamin Butterworth, November 1, 1883.
M. V. Montgomery, March 23, 1885.
B. J. Hall, April 12, 1887.
C. E. Mitchell, April 1, 1889.
William E. Simonds, August 1, 1891.
John S. Seymour, March 31, 1893.
Benjamin Butterworth, April 7, 1897.
Charles H. Duell, February 3, 1898.
F. I. Allen, April 11, 1901.

Commissioner Fisher was the first to publish his decisions and to have the copies of the specifications and drawings made by photo-lithography. He also instituted the practice of requiring competitive examinations for entrance to and promotions in the examining force of the office.

Beginning in 1843 and annually thereafter the Patent Office reports were published, which, until 1853, contained merely an alphabetical index of the names of the inventors, a list of the expired patents, and the claims of the patents granted during the week. In 1853 and afterward small engraved copies of a portion of the drawings were added to the reports to explain the claims.

The act of 1870 authorized the Commissioner to print copies of the claims of the current issues of patents and of such laws, decisions, and rules as were necessary for the information of the public. In conformity with this provision there was published weekly a list giving the numbers, titles, and claims of the patents issued during the week immediately preceding, together with the names and residences of the patentees. This list was first published under the name of The Official Gazette of the United States Patent Office, on January 3, 1872. In July, 1872, portions of the drawings were introduced to illustrate the

claims in the patented cases. The Official Gazette has now become one of the most valuable and important of Government publications. Each Senator and Representative is authorized to designate eight public libraries to receive this publication free. One copy is also furnished free to each member of Congress. It is also sent all over the world in exchange for similar publications by other Governments, and its paid subscription list is constantly increasing.

The American patent system is known and spoken of as the "examination system," in contradistinction to the English system, which has been mainly followed by other nations. The examination system is the ideal system, provided the examination can be made with sufficient care to minimize the likelihood of the issue of patents for inventions not of a patentable nature. The field of search, however, yearly increases, and it becomes more and more difficult through lack of time to make a perfect examination. Something more than two million domestic and foreign patents have been issued while the number of scientific publications has enormously increased. It is only by means of a perfect classification that this great mass of matter can be so divided as to be conveniently accessible for use in the examination of any individual case.

Of our patent system it has been well said:

"It is generally recognized by the most profound students of our institutions, both at home and abroad, that no one thing has contributed more to the pre-eminence of this country in the industrial arts and in manufactures than the encouragement given by our Constitution and laws to inventors and to investors in patent property."

The system is by no means perfect; but it is generally acknowledged that the patent laws of the United States are more liberal than those of any other country, and that the examination, imperfect though at times it be, gives a value to a United States patent not possessed by a patent issued by a country not having an examination system. It is undoubtedly true that the practice before the Patent Office lacks stability and uniformity by reason of the frequent changes of Commissioners, which prevents the establishment of definite policies. The salaries paid to the Commissioner and Assistant Commissioner, to the examiners in chief, and to the examiners of the various grades are inadequate. It is also true that too many appeals are permitted, and interference proceedings are rendered onerous and complicated by the number of motions and appeals provided by the laws and rules. The most serious defect, however, follows from the power to keep applications in the Office for indefinite times through delays in amending the same. The act of March 3, 1897, was intended to prevent or check this evil; but it has failed of its purpose. At the present time about 75 per cent of the patents granted are issued within one year after being filed, and were it not for the fact that applications are unduly delayed at least 90 per cent would issue within that time. The rights of the public would be protected and very seldom would an injustice be done to an inventor if provision was incorporated into the patent laws providing that unless an application became involved in an interference it should not be permitted to remain in the Patent Office more than three years without abridging its life of seventeen years.

The records of the Office show that there were pending in 1900, 4,829 applications, filed prior to January 1, 1898. Three of these applications were filed in 1880, one in 1881, four in 1882, three in 1884, three in 1885, thirteen in 1886, seven in 1887, thirteen in 1888, nineteen in 1889, twenty-three in 1890, forty-five in 1891, sixty-four in 1892, one hundred and three in 1893, one hundred and fifty-four in 1894, three hundred and sixty-eight in 1895, nine hundred and ninety-two in 1896, and three thousand and eleven in 1897.

It will be seen, therefore, that an application may be kept alive indefinitely, if it be desired. While the list above given embraces only such applications as were filed under the law as it existed prior to January 1, 1898, yet ten years later a similar list will undoubtedly be given, provided the statutes are not amended, for the only difference lies in the fact that amendments now have to be made within a year after the official action instead of two years under the prior act. A law which permits this should be corrected.

It should continue to be the policy of the government of a nation whose inventors have given to the world the cotton-gin and the reaper, the sewing machine and the typewriter, the electric telegraph and telephone, the rotary web perfecting printing press and

the linotype, the incandescent lamp and the phonograph, and thousands of other inventions that have revolutionized every industrial art, to encourage invention in every lawful way and to provide that, so far as may be necessary, the money paid to the Government by inventors be used for their benefit. The wisdom of the policy has been demonstrated.

The world owes as much to inventors as to statesmen or warriors. To them the United States is the greatest debtor, so much have they advanced American manufactures. Their labor-saving machinery does work that it would take millions of men using hand implements to perform. In this century the debt will be piled still higher, for inventors never rest.—Abstract of report for 1900.

C. H. DUELL,
Commissioner of Patents.

THE COPYRIGHT LAW OF THE UNITED STATES.

CONSTITUTION, 1787.

Art. 1, Sec. 8. The Congress shall have power * * * To promote the progress of science and useful arts, by Securing for Limited Times to Authors and Inventors the Exclusive Right to their Respective Writings and Discoveries.

ACTS OF CONGRESS.

Sec. 4948. All records and other things relating to copyrights and required by law to be preserved, shall be under the control of the Librarian of Congress, and kept and preserved in the Library of Congress.

[The Appropriation Act approved February 19, 1897, provides for the appointment of a "Register of Copyrights, who shall, on and after July 1, 1897, under the direction and supervision of the Librarian of Congress, perform all the duties relating to copyrights, and shall make weekly deposits with the Secretary of the Treasury, and make monthly reports to the Secretary of the Treasury, and to the Librarian of Congress, and shall, on and after July 1, 1897, give bond to the Librarian of Congress, in the sum of $20,000, with approved sureties. for the faithful discharge of his duties."]

Sec. 4949. The seal provided for the office of the Librarian of Congress shall be the seal thereof, and by it all records and papers issued from the office, and to be used in evidence shall be authenticated.

Sec. 4950. The Appropriation Act, approved February 19, 1897, provides: "The Librarian of Congress shall on and after July 1, 1897, give bond, payable to the United States, in the sum of $20,000, with sureties approved by the Secretary of the Treasury, for the faithful discharge of his duties according to law."

Sec. 4951. The Librarian of Congress shall make an annual report to Congress of the number and description of copyright publications for which entries have been made during the year.

Sec. 4952. The author, inventor, designer, or proprietor of any book, map, chart, dramatic or musical composition, engraving, cut, print, or photograph or negative thereof, or of a painting, drawing, chromo, statue, statuary, and of models or designs intended to be perfected as works of the fine arts, and the executors, administrators, or assigns of any such person shall, upon complying with the provisions of this chapter, have the sole liberty of printing, reprinting, publishing, completing, copying, executing, finishing, and vending the same; and, in the case of dramatic composition, of publicly performing or representing it, or causing it to be performed or represented by others; and authors or their assigns shall have exclusive right to dramatize and translate any of their works for which copyright shall have been obtained under the laws of the United States.

In the construction of this act the words "engraving," "cut," and "print," shall be applied only to pictorial illustrations or works connected with the fine arts, and no prints or labels designed to be used for any other articles of manufacture shall be entered under the copyright law, but may be registered in the Patent Office. And the Commissioner of Patents is hereby charged with the supervision and control of the entry or registry of such prints or labels, in conformity with the regulations provided by law as to copyright of prints, except that there shall be paid for recording the title of any print or label, not a trade-mark, $6.00, which shall cover the expense of furnishing a copy of the record, under the seal of the Commissioner of Patents, to the party entering the same.

Sec. 4953. Copyrights shall be granted for the term of twenty-eight years from the time of recording the title thereof, in the manner hereinafter directed.

Sec. 4954. The author, inventor, or designer, if he be still living, or his widow or children, if he be dead, shall have the same exclusive right continued for the further term of fourteen years, upon recording the title of the work or description of the article so secured a second time, and complying with all other regulations in regard to original copyrights, within six months before the expiration of the first term. And such person shall, within two months from the date of said renewal, cause a copy of the record thereof to be published in one or more newspapers, printed in the United States, for the space of four weeks.

Sec. 4955. Copyrights shall be assignable in law by any instrument of writing, and such assignment shall be recorded in the office of the Librarian of Congress within sixty days after its execution; in default of which it shall be void as against any subsequent purchaser or mortgagee for a valuable consideration, without notice.

Sec. 4956. No person shall be entitled to a copyright unless he shall, on or before the day of publication, in this or any foreign country, deliver at the office of the Librarian of Congress, or deposit in the mail within the United States, addressed to the Librarian of Congress, at Washington, D. C., a printed copy of the title of the book, map, chart, dramatic or musical composition, engraving, cut, print, photograph, or chromo, or a description of the painting, drawing, statue, statuary, or a model or design, for a work of the fine arts, for which he desires a copyright; nor unless he shall also, not later than the day of the publication thereof, in this or any foreign country, deliver at the office of the Librarian of Congress, at Washington, D. C., or deposit in the mail within the United States, addressed to the Librarian of Congress, at Washington, D. C., two copies of such copyright book, map, chart, dramatic or musical composition, engraving, chromo, cut, print or photograph, or in case of a painting, drawing, statue, statuary, model or design for a work of the fine arts, a photograph of the same: Provided. That in the case of a book, photograph, chromo, or lithograph, the two copies of the same required to be delivered or deposited as above, shall be printed from type set within the limits of the United States, or from plates made therefrom, or from negatives, or drawings on stone made within the limits of the United States, or from transfers made therefrom. During the existence of such copyright the importation into the United States of any brook, chromo, lithograph, or photograph, so copyrighted, or any edition or editions thereof, or any plates of the same not made from type set, negatives, or drawings on stone made within the limits of the United States, shall be, and is hereby prohibited, except in the cases specified in paragraphs 512 to 516, inclusive, in Section 2 of the act entitled An Act to reduce the revenue and equalize the duties on imports and for other purposes, approved October 1, 1890; and except in the case of persons purchasing for use and not for sale, who import subject to the duty thereon, not more than two copies of such books at any one time; and, except in the case of newspapers and magazines, not containing in whole or in part matter copyrighted under the provisions of this act, unauthorized by the author, which are hereby exempted from prohibition of importation;

Provided, nevertheless, That in the case of books in foreign languages, of which only translations in English are copyrighted, the prohibition of importation shall apply only to the translation of the same, and the importation of the books in the original language shall be permitted.

Sec. 4957. The Librarian of Congress shall record the name of such copyright book, or other article, forthwith in a book to be kept for that purpose, in the words following: "Library of Congress, to wit: Be it remembered that on the —— day of ——, A. B., of ——, hath deposited in this office the title of a book (map, chart, or otherwise, as the case may be, or description of the article), the title or description of which is in the following words, to wit: (here insert the title or description), the right whereof he claims as author (originator, or proprietor, as the case may be), in conformity with the laws of the United States respecting copyrights. C. D., Librarian of Congress." And he shall give a copy of the title or description under the seal of the Librarian of Congress, to the proprietor, whenever he shall require it.

Sec. 4958. The Librarian of Congress shall receive from the persons to

whom the services designated are rendered, the following fees: 1. For recording the title or description of any copyright book or other article, 50 cents. 2. For every copy under seal of such record actually given to the person claiming the copyright, or his assigns, 50 cents. [3. For recording and certifying any instrument of writing for the assignment of a copyright, $1.00. 4. For every copy of an assignment, $1.00.] All fees so received shall be paid into the treasury of the United States: Provided, That the charge for recording the title or description of any article entered for copyright, the production of a person not a citizen or resident of the United States, shall be $1.00, to be paid as above into the treasury of the United States, to defray the expenses of lists of copyrighted articles as hereinafter provided for.

And it is hereby made the duty of the Librarian of Congress to furnish to the Secretary of the Treasury copies of the entries of titles of all books and other articles wherein the copyright has been completed by the deposit of two copies of such book printed from type set within the limits of the United States, in accordance with the provisions of this act, and by the deposit of two copies of such other article made or produced in the United States; and the Secretary of the Treasury is hereby directed to prepare and print, at intervals of not more than a week, catalogues of such title-entries for distribution to the collectors of customs of the United States, and to the postmasters of all post-offices receiving foreign mails, and such weekly lists, as they are issued, shall be furnished to all parties desiring them, at a sum not exceeding five dollars per annum, and the Secretary and the Postmaster-General are hereby empowered and required to make and enforce such rules and regulations as shall prevent the importation into the United States, except upon the conditions above specified, of all articles prohibited by this act.

Sec. 4959. The proprietor of every copyright book or other article shall deliver at the office of the Librarian of Congress, or deposit in the mail, addressed to the Librarian of Congress, at Washington, D. C., a copy of every subsequent edition wherein any substantial changes shall be made: Provided, however, That the alterations, revisions, and additions made to books by foreign authors, heretofore published, of which new editions shall appear subsequently to the taking effect of this act, shall be held and deemed capable of being copyrighted as above provided for in this act, unless they form a part of the series in course of publication at the time this act shall take effect.

Sec. 4960. For every failure on the part of the proprietor of any copyright to deliver, or deposit in the mail, either of the published copies, or description, or photograph, required by sections 4956 and 4959, the proprietor of the copyright shall be liable to a penalty of $25.00, to be recovered by the Librarian of Congress, in the name of the United States, in an action in the nature of an action of debt, in any district court of the United States within the jurisdiction of which the delinquent may reside or be found.

The following act in relation to the deposit of copies was approved March 3, 1893: "That any author, inventor, designer, or proprietor of any book, or other article entitled to copyright, who has heretofore failed to deliver in the office of the Librarian of Congress, or in the mail addressed to the Librarian of Congress, two complete copies of such book, or description or photograph of such article, within the time limited by title 60, chapter 3, of the Revised Statutes, relating to copyrights, and the acts in amendment thereof, and has complied with all other provisions thereof, who has, before the first day of March, 1893, delivered at the office of the Librarian of Congress, or deposited in the mail addressed to the Librarian of Congress two complete printed copies of such book, or description or photograph of such article, shall be entitled to all the rights and privileges of said title sixty, chapter three, of the Revised Statutes and the acts in amendment thereof.

Sec. 4961. The postmaster to whom such copyright book, title, or other article is delivered, shall, if requested, give a receipt therefor; and when so delivered he shall mail it to its destination.

Sec. 4962. No person shall maintain an action for the infringement of his copyright unless he shall give notice thereof by inserting in the several copies of every edition published, on the title-page, or the page immediately following, if it be a book; or if a map, chart, musical composition, print, cut, engraving, photograph, painting, draw-

ing, chromo, statue, statuary, or model or design intended to be perfected and completed as a work of the fine arts, by inscribing upon some visible portion thereof, or of the substance on which the same shall be mounted, the following words, viz.: "Entered according to act of Congress, in the year ——, by A. B., in the office of the Librarian of Congress, at Washington"; or, at his option, the word "Copyright," together with the year the copyright was entered, and the name of the party by whom it was taken out, thus: "Copyright, 18—, by A. B."

That manufacturers of designs for moulded decorative articles, tiles, plaques, or articles of pottery or metal subject to copyright may put the copyright mark prescribed by Section 4962 of the Revised Statutes, and acts additional thereto, upon the back or bottom of such articles, or in such other place upon them as it has heretofore been usual for manufacturers of such articles to employ for the placing of manufacturers, merchants, and trademarks thereon.

Sec. 4963. Every person who shall insert or impress such notice, or words of the same purport, in or upon any book, map, chart, dramatic or musical composition, print, cut, engraving or photograph, or other article, whether such article be subject to copyright or otherwise, for which he has not obtained a copyright, or shall knowingly issue or sell any article bearing a notice of a United States copyright which has not been copyrighted in this country; or shall import any book, photograph, chromo, or lithograph or other article bearing such notice of copyright or words of the same purport, which is not copyrighted in this country, shall be liable to a penalty of $100, recoverable one-half for the person who shall sue for such penalty, and one-half to the use of the United States; and the importation into the United States of any book, chromo, lithograph, or photograph, or other article bearing such notice of copyright, when there is no existing copyright thereon in the United States, is prohibited; and the circuit courts of the United States sitting in equity are hereby authorized to enjoin the issuing, publishing, or selling of any article marked or imported in violation of the United States copyright laws, at the suit of any person complaining of such violation: Provided, That this act shall not apply to any importation of or sale of such goods or articles brought into the United States prior to the passage hereof.

Sec. 4964. Every person who, after the recording of the title of any book and the depositing of two copies of such book as provided by this act, shall, contrary to the provisions of this act, within the term limited, and without the consent of the proprietor of the copyright first obtained in writing, signed in presence of two or more witnesses, print, publish, dramatize, translate, or import, or, knowing the same to be so printed, published, dramatized, translated, or imported, shall sell or expose to sale any copy of such book, shall forfeit every copy thereof to such proprietor, and shall also forfeit and pay such damages as may be recovered in a civil action by such proprietor in any court of competent jurisdiction.

Sec. 4965. If any person, after the recording of the title of any map, chart, dramatic or musical composition, print, cut, engraving, or photograph, or chromo, or of the description of any painting, drawing, statue, statuary, or model or design intended to be perfected and executed as a work of the fine arts, as provided by this act, shall, within the term limited, contrary to the provisions of this act, and without the consent of the proprietor of the copyright first obtained in writing, signed in presence of two or more witnesses, engrave, etch, work, copy, print, publish, dramatize, translate, or import, either in whole or in part, or by varying the main design, with intent to evade the law, or knowing the same to be so printed, published, dramatized, translated, or imported, shall sell or expose to sale any copy of such map, or other article, as aforesaid, he shall forfeit to the proprietor all the plates on which the same shall be copied, and every sheet thereof, either copied or printed, and shall further forfeit $1.00 for every sheet of the same found in his possession, either printing, printed, copied, published, imported, or exposed for sale; and in case of a painting, statue, or statuary, he shall forfeit $10.00 for every copy of the same in his possession, or by him sold or exposed for sale: Provided, however, That in case of any such infringement of the copyright of a photograph made from any object not a work of fine arts, the sum to be recovered in any action brought under the provisions of this section

shall be not less than $100, nor more than $5,000, and: Provided, further, That in case of any such infringement of the copyright of a painting, drawing, statue, engraving, etching, print, or model or design for a work of the fine arts, or of a photograph of a work of the fine arts, the sum to be recovered in any action brought through the provisions of this section shall be not less than $250, and not more than $10,000. One-half of all the foregoing penalties shall go to the proprietors of the copyright and the other half to the use of the United States.

Sec. 4966. Any person publicly performing or representing any dramatic or musical composition for which a copyright has been obtained, without the consent of the proprietor of said dramatic or musical composition, or his heirs or assigns, shall be liable for damages therefor, such damages in all cases to be assessed at such sum, not less than $100 for the first, and $50 for every subsequent performance, as to the court shall appear to be just. If the unlawful performance and representation be wilful and for profit such person or persons shall be guilty of a misdemeanor, and upon conviction be imprisoned for a period not exceeding one year. Any injunction that may be granted upon hearing after notice to the defendant by any circuit court in the United States, or by a judge thereof, restraining and enjoining the performance or representation of any such dramatic or musical composition may be served on the parties against whom such injunction may be granted anywhere in the United States, and shall be operative and may be enforced by proceedings to punish for contempt or otherwise by any other circuit court or judge in the United States; but the defendants in said action, or any or either of them, may make a motion in any other circuit in which he or they may be engaged in performing or representing said dramatic or musical composition to dissolve or set aside the said injunction upon such reasonable notice to the plaintiff as the circuit court or the judge before whom said motion shall be made shall deem proper; service of said motion to be made on the plaintiff in person or on his attorneys in the action. The circuit courts or judges thereof shall have jurisdiction to enforce said injunction and to hear and determine a motion to dissolve the same, as herein provided, as fully as if the action were pending or brought in the circuit in which said motion is made.

The clerk of the court, or judge granting the injunction, shall, when required so to do by the court hearing the application to dissolve or enforce said injunction, transmit without delay to said court a certified copy of all the papers on which the said injunction was granted that are on file in his office.

Sec. 4967. Every person who shall print or publish any manuscript whatever, without the consent of the author or proprietor first obtained shall be liable to the author or proprietor for all damages occasioned by such injury.

Sec. 4968. No action shall be maintained in any case of forfeiture or penalty under the copyright laws, unless the same is commenced within two years after the cause of action has arisen.

Sec. 4969. In all actions arising under the laws respecting copyrights the defendant may plead the general issue, and give the special matter in evidence.

Sec. 4970. The circuit courts, and district courts having the jurisdiction of circuit courts, shall have power, upon bill in equity, filed by any party aggrieved, to grant injunctions to prevent the violation of any right secured by the laws respecting copyrights, according to the course and principles of courts of equity, on such terms as the court may deem reasonable.

Sec. 4971.

[Revised Statutes, title 13, THE JUDICIARY, provides as follows: Chap. 7 (sec. 629). The circuit courts shall have original jurisdiction as follows: * * * Ninth. Of all suits at law or in equity arising under the patent or copyright laws of the United States. A writ of error may be allowed to review any final judgment at law, and an appeal shall be allowed from any final decree in equity hereinafter mentioned, without regard to the sum or value in dispute: First. Any final judgment at law or final decree in equity of any circuit court, or of any district court acting as a circuit court, or of the supreme court of the District of Columbia, or of any Territory, in any case touching patent rights or copyrights. (Rev. Stat., 1878, p. 130.) Chap. 12 (sec. 711). The jurisdiction vested in the courts of the United States in the cases and proceedings hereafter mentioned, shall be exclusive of the courts of the sev-

eral States: * * * Fifth. Of all cases arising under the patent-right or copyright laws of the United States. (Rev. Stat., 1878, pp. 134, 135.) Chap. 18 (sec. 972). In all recoveries under the copyright laws, either for damages, forfeiture, or penalties, full costs shall be allowed thereon. (Rev. Stat., 1878, p. 183.)]

The act approved March 3, 1891 (51st Congress, 1st session, chap. 565: 26 Statutes at Large, pp. 1106-1110), in addition to the amendments, noted above, of sections 4952, 4954, 4956, 4958, 4959, 4963, 4964, 4965, and 4967, provides further as follows:

"That for the purpose of this act each volume of a book in two or more volumes, when such volumes are published separately, and the first one shall not have been issued before this act shall take effect, and each number of a periodical shall be considered an independent publication, subject to the form of copyrighting as above." (Sec. 11.)

"That this act shall go into effect on the first day of July, 1891." (Sec. 12.)

"That this act shall only apply to a citizen or subject of a foreign state or nation when such foreign state or nation permits to citizens of the United States of America the benefit of copyright on substantially the same basis as its own citizens; or when such foreign state or nation is a party to an international agreement which provides for reciprocity in the granting of copyright, by the terms of which agreement the United States of America may at its pleasure become a party to such agreement. The existence of either of the conditions aforesaid shall be determined by the President of the United States, by proclamation made from time to time as the purposes of this act may require." (Sec. 13.)

[An Act providing for the public printing and binding and the distribution of public documents (January 12, 1895, 53d Congress, 3d session, chap. 23, sec. 52: 28 Statutes at Large, p. 608), provides as follows: The Public Printer shall sell, under such regulations as the Joint Committee on Printing may prescribe, to any person or persons who may apply, additional or duplicate stereotype or electrotype plates from which any Government publication is printed, at a price not to exceed the cost of composition, the metal and making to the Government and 10 per centum added: Provided, That the full amount of the price shall be paid when the order is filed: And provided, further, That no publication reprinted from such stereotype or electrotype plates and no other Government publication shall be copyrighted.]

CHAPTER X.

MANUFACTURES, EXPORTS AND IMPORTS.

LOCALIZATION OF SPECIFIED INDUSTRIES, BY STATES: 1900.

Industry.	Value of Products in Continental United States.	State.	Value of Products in the State Named.	Per Cent of Continental United States in the State Named.
Collars and cuffs	$15,769,132	New York	$15,703,541	99.6
Plated and britannia ware	12,608,770	Connecticut	9,538,397	75.7
Oysters, canning and preserving	3,670,134	Maryland	2,417,331	65.9
Leather gloves and mittens	16,721,234	New York	10,854,221	64.9
Clocks	7,157,856	Connecticut	4,545,047	63.5
Coke	35,585,445	Pennsylvania	22,282,358	62.6
Safes and vaults	3,927,867	Ohio	2,407,655	61.3
Whips	2,734,471	Massachusetts	1,651,221	60.4
Liquors, vinous	6,547,310	California	3,937,871	60.1
Brassware	17,140,075	Connecticut	9,269,159	54.1
Iron and steel	803,968,273	Pennsylvania	434,445,200	54.0
Carpets and rugs, other than rag	48,192,351	Pennsylvania	23,113,058	48.0
Corsets	14,878,116	Connecticut	6,846,946	46.0
Boots and shoes, factory product	261,028,580	Massachusetts	117,115,243	44.9
Agricultural implements	101,207,428	Illinois	42,033,796	41.5
Slaughtering and meat packing, wholesale	698,206,548	Illinois	279,842,835	40.1
Turpentine and rosin	20,344,888	Georgia	8,110,468	39.9
Cotton, ginning	14,748,270	Texas	5,886,923	39.9
Liquors, distilled	96,798,443	Illinois	38,208,076	39.5
Glass	56,539,712	Pennsylvania	22,001,130	38.9
Hosiery and knit goods	95,482,566	New York	35,886,048	37.6
Silk and silk goods	107,256,258	New Jersey	39,966,662	37.3
Silverware	10,569,121	Rhode Island	3,834,408	36.3
Salt	7,966,897	New York	2,698,691	33.9
Cotton goods	339,200,320	Massachusetts	111,125,175	32.8
Jewelry	46,501,181	Rhode Island	13,320,620	28.6
Leather, tanned, curried, and finished	204,038,127	Pennsylvania	55,615,009	27.3
Fur hats	27,811,187	Connecticut	7,546,882	27.2
Pottery, terra cotta, and fire-clay products	44,263,386	Ohio	11,851,225	26.8
Paper and wood pulp	127,326,162	New York	26,715,628	21.0

—*Twelfth Census.*

MANUFACTURING IN THE UNITED STATES—

Class.	Number of Establishments.	Capital.	Proprietors and Firm Members	Wage-earners.	
				Average Number.	Total Wages
Total	640,056	$9,858,205,501	708,623	5,370,814	$2,323,055,634
Hand trades	215,814	392,442,255	242,154	559,130	288,118,421
Governmental establishments	138	....	....	....	....
Educational, eleemosynary, and penal institutions	381	....	....	....	....
Establishments with a product of less than $500	127,346	44,371,111	136,054	64,671	2,117,466
All other establishments	296,377	9,421,392,135	330,415	4,747,013	2,032,819,747

Statistics for governmental establishments, educational, eleemosynary, and penal insti-

MANUFACTURING IN THE UNITED STATES

[Twelfth Census,

Items.	Date of Census.		
	1900.[1]	1890.	1880.
Number of establishments	512,276	355,405	253,852
Capital	$9,831,486,500	$6,525,050,759	$2,790,272,606
Salaried officials, clerks, etc., number	397,092	[2] 461,001	([3])
Salaries	$404,112,794	[2] $391,984,660	([3])
Wage-earners, average number	5,314,539	4,251,535	2,732,595
Total wages	$2,327,295,545	$1,891,209,696	$947,953,795
Men, at least 16 years of age	4,114,348	3,326,964	2,019,035
Wages	$2,019,954,204	$1,659,215,858	([3])
Women, at least 16 years of age	1,031,608	803,686	531,639
Wages	$281,679,649	$215,367,976	([3])
Children, under 16 years	168,583	120,885	181,921
Wages	$25,661,692	$16,625,862	([3])
Miscellaneous expenses	$1,027,865,277	$631,219,783	([5])
Cost of materials used	$7,346,358,979	$5,162,013,878	$3,396,823,549
Value of products, incl. custom work, etc.	$13,010,036,514	$9,372,378,843	$5,3C9,579,191

[1] Includes, for comparative purposes, 85 governmental establishments in the District of Columbia having products valued at $9,887,355, the statistics for such establishments for 1890 not being separable.

[2] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table.

[3] Not reported separately.

[4] Decrease.

[5] Not reported.

NOTE.—Exact comparisons between the censuses shown in this table are difficult and sometimes impossible on account of changes which have taken place from census to census in the form of inquiries contained in the schedules, in the industries canvassed, and in the methods of compilation. Comparisons between the censuses of 1890 and 1900 are more exact than has ever before been the case; but even between these two censuses there are certain important differences in the forms of inquiry, or the methods of handling the statistics in compilation, to which careful attention should be paid.

1. Capital.—It cannot be assumed that any true comparability exists between the statistics on this subject elicited prior to 1890. At the census of 1880 the question read: "Capital (real and personal) invested in the business." At the census of 1890 live capital, i.e., cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries, was for the first time included as a separate and distinct item of capital, and the capital invested in realty was divided between land, buildings, and machinery. The form of this inquiry at the census of 1890 and 1900 was so similar that comparison may be safely made.

2. Salaried Officials.—No comparison of the statistics of the number and salaries or salaried officials of any character can be made between the reports of any censuses. Not until the census of 1890 did the census begin to differentiate sharply between salaried officials, i.e.,

SUMMARY FOR ALL ESTABLISHMENTS: 1900.

Miscellaneous Expenses.	Cost of Materials Used.				Value of Products, Including Custom Work and Repairing.
	Total.	Purchased in Raw State.	Purchased in Partially Manufactured Form.	Fuel, Freight, etc.	
$1,030,110,125	$7,363,132,083	$2,391,668,276	$4,648,561,271	$322,902,536	$13,058,562,917
124,623,253	482,736,991	8,851,162	462,510,619	11,375,210	1,183,615,478
....	6,917,518	60,576	6,607,447	249,495	22,010,391
....	3,690,916	1,037,343	2,365,089	288,484	6,640,692
2,524,681	8,895,774	1,431,529	7,437,420	26,825	29,762,675
902,962,191	6,860,890,884	2,380,287,666	4,169,640,696	310,962,522	11,816,533,681

tutions, and establishments with a product of less than $500, are included in Table only.

—COMPARATIVE SUMMARY: 1850 TO 1900.

Vols. VII. and VIII.

Date of Census.			Per Cent of Increase.				
1870.	1860.	1850.	1890 to 1900.	1880 to 1890.	1870 to 1880.	1860 to 1870.	1850 to 1860.
252,148	140,433	123,025	44.1	40.0	0.7	79.6	14.1
$2,118,208,769	$1,009.855,715	$533,245,351	50.7	133.8	31.7	109.8	89.4
(3)	(3)	(3)	[4] 13.9	....	....	....	....
(3)	(3)	(3)	3.1	....	....	....	....
2,053,996	1,311,246	957,059	25.0	55.6	33.0	56.6	37.0
$775,584,343	$378,878,966	$236,755,464	23.1	99.5	22.2	104.7	60.0
1,615,598	1,040,349	731,137	23.7	64.8	25.0	55.3	42.3
(3)	(3)	(3)	21.7	....	....	....	....
323,770	270,897	225,922	28.4	51.2	64.2	19.5	19.9
(3)	(3)	(3)	30.8	....	....	....	....
114,628	(3)	(3)	39.5	[4] 33.6	58.7	....	....
(3)	(3)	(3)	54.3	....	....	....	....
(5)	(5)	(5)	62.8	....	....	....	....
$2,488,427,242	$1,031,605,092	$555,123,822	42.3	52.0	36.5	141.2	85.8
$4,232,325,442	$1,885,861,676	$1,019,106,616	38.8	74.5	26.9	124.4	85.1

employees engaged at a fixed compensation per annum, and the wage-earning class, i.e., employees paid by the hour, the day, the week, or the piece, for work performed and only fof such work. Prior to 1890 such salaried officials, if returned at all, were returned with the wage-earners proper. At the census of 1890 the number and salaries of proprietors and firm members actively engaged in the business, or in supervision, were reported, combined with clerks and other officials. Where proprietors and firm members were reported without salaries, the amount that would ordinarily be paid for similar services was estimated. At the census of 1900 the number of proprietors and firm members actively engaged in industry or in supervision was ascertained, but no salaries were reported for this class, salaries, as a matter of fact, being rarely paid in such cases, proprietors and firm members depending upon the earnings of the business for their compensation.

3. Employees and Wages.—At the censuses of 1850 and 1860 the inquiries regarding employees and wages called for "the average number of hands employed: male, female," "the average monthly cost of male labor," and "the average monthly cost of female labor." At the census of 1870 the average number of hands employed was called for, divided between "males above 16 years, females above 15 years, and children and youth," and the "total amount paid in wages during the year" was first called for. The inquiries at the census of 1880 were like those of 1870, though more extended for some of the selected industries.

At the census of 1890 the average number of persons employed during the entire year was called for, and also the average number employed at stated weekly rates of pay, and the average number was computed for the actual time the establishments were reported as being in operation. At the census of 1900 the greatest and least numbers of employees were reported and also the average number employed during each month of the year. The average number of wage-earners (men, women, and children) employed during the entire year was computed in the Census Office by using 12, the number of calendar months, as a divisor into the total of the average numbers reported for each month. This difference in the method of ascertain-

ing the average number of wage-earners during the entire year resulted in a variation in the average number as between the two censuses.

Furthermore, the schedules for 1890 included in the wage-earning class "overseers, and foremen or superintendents (not general superintendents or managers)," while the census of 1900 separates from the wage-earning class such salaried employees as general superintendents, clerks, and salesmen. It is probable that this change in the form of the question has resulted in eliminating from the wage-earners, as reported by the present census, many high-salaried employees included in 1890.

4. Miscellaneous Expenses.—This item was not shown at any census prior to that of 1890. Comparison between the totals reported can safely be made between the last two censuses.

5. Materials.—The same statement is true regarding the materials used in manufactures. With the exception of the schedules on which a few selected industries were reported at the census of 1880, the question concerning materials was as follows: "Value of materials used (including mill supplies and fuel)." At the census of 1890 the schedule contained separate questions as to the kind, quantity, and cost of the principal materials, and the cost of "mill supplies," "fuel," and "all other materials." The amounts paid for rent of power and heat were also included under this head in 1890. It is probable that some of the items included the cost of materials at the census of 1880 were included in "miscellaneous expenses" at the inquiries of 1890 and 1900.

6. Products.—These statistics are comparable beginning with the census of 1870.

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900.

[Twelfth Census, Vol. VII. page 3, and Vol. VIII. page 18.]

Industry.	Number of Establishments.	Capital.	Wage-earners.		Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
			Average Number	Total Wages.		
Total	512,191	$9,813,834,390	5,306,143	$2,320,938,168	$7,343,627,875	$13,000,149,159
Agricultural implements	715	157,707,951	46,582	22,450,880	43,944,628	101,207,428
Ammunition	33	6,719,081	5,231	2,560,954	7,436,748	13,027,635
Artificial feathers and flowers	227	3,633,869	5,333	1,561,763	2,765,151	6,297,805
Artificial limbs	87	290,104	249	146,620	126,062	749,854
Artists' materials	21	376,736	200	79,267	249,107	497,046
Awnings, tents, and sails	858	4,342,728	4,400	2,038,613	6,480,685	11,728,843
Axle grease	29	577,195	127	55,238	360,411	718,114
Babbitt metal and solder	51	3,115,568	535	294,584	7,998,369	9,191,409
Bags, other than paper	78	7,696,732	4,039	1,133,128	16,849,311	20,123,486
Bags, paper	63	6,900,291	2,029	683,783	4,659,001	7,359,975
Baking and yeast powders	191	8,337,723	1,938	717,000	7,126,967	14,568,380
Baskets, & rattan and willow ware	550	2,989,568	4,396	1,280,511	1,398,374	3,851,244
Bells	23	1,038,305	663	307,991	602,856	1,247,730
Belting and hose, leather	105	7,410,219	1,667	913,937	7,500,413	10,623,177
Belting and hose, linen	7	526,059	254	64,102	452,430	717,137
Belting and hose, rubber	18	5,493,885	1,771	918,191	4,075,702	6,169,044
Bicycle and tricycle repairing	6,328	6,760,070	5,749	2,505,974	5,224,886	13,766,033
Bicycles and tricycles	312	29,783,659	17,525	8,189,817	16,792,051	31,915,908
Billiard tables and materials	75	884,901	455	278,218	730,046	1,650,868
Blacking	121	2,718,504	1,250	424,174	2,186,809	4,504,965
Blacksmithing and wheelwrighting	51,771	54,976,341	36,193	17,974,264	24,701,632	85,971,630
Bluing	65	415,119	220	79,380	244,970	575,804
Bone, ivory, and lamp black	15	782,247	85	46,107	105,712	359,787

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners.		Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
			Average Number	Total Wages.		
Bookbinding and blank-book making	954	$12,744,628	15,971	$6,671,666	$7,702,543	$20,790,858
Boot and shoe cut stock	342	7,003,080	6,155	2,230,691	17,800,282	23,242,892
Boot and shoe findings	186	3,277,958	2,993	1,127,784	4,627,048	7,145,820
Boot and shoe uppers	132	273,796	256	125,627	401,680	700,225
Boots and shoes, custom work and repairing	23,560	9,262,134	9,698	4,128,361	8,288,664	26,550,678
Boots and shoes, factory product	1,600	101,795,233	142,922	59,175,883	169,604,054	261,028,580
Boots and shoes, rubber	22	33,667,533	14,391	6,426,579	22,682,543	41,089,819
Bottling	2,064	16,620,152	7,680	3,589,447	28,087,823	41,640,672
Boxes, cigar	315	3,288,272	4,609	1,439,599	3,061,193	5,856,915
Boxes, fancy and paper	729	14,979,305	27,653	8,151,625	11,765,424	27,316,317
Boxes, wooden packing	896	21,952,757	22,034	7,827,955	22,807,627	38,216,384
Brass	10	503,367	162	98,796	1,152,635	1,419,817
Brass and copper, rolled	19	15,629,766	6,759	3,512,781	30,000,632	37,536,325
Brass castings and brass finishing	442	21,925,039	11,964	6,070,762	18,871,141	30,343,044
Brassware	204	12,194,715	7,668	3,550,074	9,830,319	17,140,075
Bread and other bakery products	14,917	81,049,553	60,271	27,893,170	95,221,915	175,657,348
Brick and tile	5,423	82,086,438	61,979	21,883,333	11,006,148	51,270,476
Bridges	196	16,768,948	12,181	6,711,260	16,258,561	30,151,624
Bronze castings	21	881,769	621	372,797	1,339,722	2,229,329
Brooms and brushes	1,526	9,616,780	10,349	3,788,046	9,546,854	18,490,847
Butter, rework'g	10	255,525	148	67,747	1,345,418	2,114,935
Buttons	238	4,212,568	8,685	2,826,238	2,803,246	7,695,910
Calcium lights	19	95,114	55	24,418	34,982	118,666
Cardboard	5	1,168,495	626	264,427	705,527	1,270,416
Card cutting and designing	43	337,642	325	135,139	312,760	618,488
Carpentering	21,315	71,327,047	123,985	71,049,737	142,419,410	316,101,758
Carpets and rugs, other than rag	133	44,449,299	28,411	11,121,383	27,228,719	48,192,351
Carpets, rag	1,014	975,190	1,504	492,656	681,311	1,993,756
Carpets, wood	31	412,357	608	362,112	418,343	1,056,702
Carriage and wagon materials	588	19,085,775	15,387	5,987,267	13,048,608	25,027,173
Carriages and sleds, children's	77	2,906,472	2,726	1,090,296	1,996,070	4,289,695
Carriages and wagons	7,632	118,187,838	62,540	29,814,911	56,676,073	121,537,276
Cars and general shop construc'n and repairs by steam railroad companies	1,295	119,473,042	173,595	96,006,570	109,472,353	218,113,658
Cars, railroad and street, and repairs, not including establishments operated by steam railroad companies	193	106,721,186	44,063	23,342,763	70,046,354	107,186,359
Celluloid and celluloid goods (1890)	12	3,158,487	939	447,120	856,180	2,575,736
Charcoal	183	811,225	1,786	431,381	405,339	1,133,638

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners. Average Number.	Wage-earners. Total Wages.	Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
Cheese, butter, and condensed milk	9,355	$36,508,015	12,865	$6,170,670	$109,151,205	$131,199,277
Chemicals	459	89,091,430	19,054	9,401,467	34,564,137	62,676,730
China decorating	169	372,017	360	148,004	261,819	693,800
Chocolate and cocoa products	24	6,890,732	1,314	525,875	6,876,682	9,666,192
Cleansing and polishing preparations	154	943,328	508	209,438	965,242	2,193,019
Clocks	46	8,792,653	6,037	2,650,703	3,028,606	7,157,856
Cloth, sponging and refinishing	46	288,894	534	268,191	17,490	566,000
Clothing, horse	26	653,545	575	176,687	847,846	1,305,164
Clothing, men's	28,014	173,034,543	191,043	79,434,932	197,742,067	415,256,391
Clothing, women's dressmaking	14,479	13,815,221	45,595	14,352,453	16,503,754	48,356,034
Clothing, wom'n's, factory product	2,701	48,431,544	83,739	32,586,101	84,704,592	159,339,539
Coffee and spice, roasting and grinding	458	28,436,897	6,387	2,486,759	55,112,203	69,527,108
Coffins, burial cases, and undertakers' goods	217	13,585,162	6,840	3,077,481	6,945,348	13,952,308
Coke	241	36,502,679	16,999	7,085,736	19,665,532	35,585,445
Collars and cuffs, paper (1890)	3	237,764	82	35,125	223,077	301,093
Combs	34	832,791	1,399	572,467	951,514	1,976,129
Confectionery	4,297	35,155,361	33,583	10,867,687	45,534,153	81,290,543
Cooperage	2,146	22,568,873	22,938	9,200,303	23,299,312	40,576,462
Copper, smelting and refining	47	53,063,395	11,324	8,529,021	122,174,129	165,131,670
Cordage and twine	105	29,275,470	13,114	4,113,112	26,632,006	37,849,651
Cordials & syrups	39	1,153,006	362	116,917	1,505,096	2,107,132
Cork, cutting	62	2,683,683	2,340	687,796	2,403,829	4,392,364
Corsets	216	7,481,048	12,729	3,791,509	6,555,467	14,878,116
Cotton, compressing	111	8,323,558	2,742	738,288	353,910	2,629,590
Cotton, ginning	11,369	23,228,130	14,135	1,930,039	3,912,303	14,748,270
Cotton goods	1,055	467,240,157	302,861	86,689,752	176,551,527	339,200,320
Cotton waste	26	2,560,759	1,116	336,827	4,950,490	5,880,024
Crucibles	11	1,843,616	671	250,654	1,673,290	2,607,308
Cutlery and edge tools	309	16,532,383	12,069	5,673,619	5,116,042	14,881,478
Dentistry, Mechanical (1890)	3,214	4,019,637	1,486	768,401	1,475,255	7,864,299
Dentists' materi'ls	68	2,112,236	1,017	508,603	2,109,231	3,721,150
Druggists' preparations, not including prescriptions	250	16,320,120	5,766	2,041,061	11,022,417	23,192,785
Drug grinding	26	2,837,911	644	291,823	3,315,228	4,308,144
Dyeing and cleaning	1,810	4,673,211	5,424	2,271,066	1,484,292	7,567,358
Dyeing and finishing textiles	298	60,643,104	29,776	12,726,316	17,958,137	44,963,331
Dye stuffs and extracts	77	7,839,034	1,647	787,942	4,745,912	7,350,748
Electrical apparatus and supplies	580	83,130,943	40,890	20,190,344	48,916,440	91,348,889
Electrical construction and repairs	1,162	5,438,087	5,949	3,312,126	7,673,507	15,907,420
Electroplating	422	1,460,692	2,275	1,036,750	836,726	3,007,455
Emery wheels	34	1,489,527	546	303,091	508,753	1,381,675
Enameling and enameled goods	129	9,184,178	7,675	2,259,003	5,466,971	9,978,509

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners.		Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
			Average Number.	Total Wages.		
Engravers' materials	12	$104,741	79	$46,064	$143,270	$289,339
Engraving and die-sinking	414	790,461	1,034	572,874	225,637	1,683,690
Engraving, steel, including plate printing	286	5,061,520	3,299	2,006,824	1,206,462	5,068,558
Engraving, wood	145	231,817	337	206,537	63,272	616,166
Envelopes	51	5,612,509	2,984	1,150,463	3,665,275	6,299,330
Explosives	97	19,465,846	4,502	2,383,756	10,334,974	17,125,418
Fancy articles, not elsewhere specified	392	5,081,806	5,718	1,921,578	4,061,400	9,046,342
Felt goods	36	7,125,276	2,688	1,024,835	3,801,028	6,461,691
Fertilizers	422	60,685,753	11,581	4,185,289	28,958,473	44,657,385
Files	86	3,857,647	3,160	1,277,199	1,166,414	3,403,906
Firearms	32	6,916,231	4,482	2,542,366	1,305,421	5,444,659
Fire extinguishers, chemical	17	136,933	64	32,828	70,874	217,833
Fireworks	46	1,086,133	1,638	506,990	627,761	1,785,271
Fish, canning and preserving	312	16,310,987	11,318	2,986,996	11,644,118	18,432,613
Flags and banners	36	666,033	509	148,933	547,165	1,038,052
Flavoring extracts	352	3,319,716	1,254	478,975	3,294,380	6,314,552
Flax, dressed	4	71,496	211	46,000	91,032	158,650
Flouring and grist mill products	25,258	218,714,104	37,073	17,703,418	475,826,345	560,719,063
Food preparations	644	20,998,102	8,154	3,051,718	23,675,165	38,457,651
Foundry and machine shop products	9,324	665,038,245	350,327	182,232,009	286,357,107	644,990,999
Foundry supplies	30	981,817	278	135,877	628,160	1,128,856
Fruits and vegetables, canning and preserving	1,808	27,743,067	36,401	8,050,793	37,524,297	56,668,313
Fur goods	994	13,373,867	8,588	4,273,192	15,113,365	27,735,264
Furnishing goods, men's	470	20,163,222	30,216	9,680,077	23,404,969	43,902,162
Furniture, including cabinetmaking, repairing, & upholstering	7,972	117,982,091	100,018	42,638,810	65,499,877	153,168,309
Furs, dressed	92	798,030	835	478,190	519,699	1,400,455
Galvanizing	28	1,775,770	535	229,406	1,677,584	2,470,703
Gas and lamp fixtures	223	10,009,239	7,642	3,504,301	5,013,597	12,577,806
Gas and oil stoves	35	3,766,065	2,471	1,138,442	2,501,568	4,579,700
Gas, illuminating and heating	877	567,000,506	22,459	12,436,296	20,605,356	75,716,693
Gas machines and meters	114	4,605,624	2,167	1,185,959	1,943,769	4,392,730
Glass	355	61,423,903	52,818	27,084,710	16,731,009	56,539,712
Glass, cutting, staining, and ornamenting	417	4,013,534	4,931	2,403,591	3,540,097	8,776,006
Gloves and mittens	394	9,089,809	14,345	4,182,518	9,483,130	16,926,156
Glucose	8	41,011,345	3,288	1,755,179	15,773,233	21,693,656
Glue	61	6,144,407	1,618	685,096	3,767,023	5,389,006
Gold and silver, leaf and foil	93	1,086,854	1,163	498,692	1,604,013	2,666,224
Gold and silver, reducing and refining, not from the ore	57	1,944,124	219	141,400	10,932,361	11,811,537
Graphite and graphite refining	11	411,128	137	64,376	216,560	429,173

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners. Average Number.	Wage-earners. Total Wages.	Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
Grease and tallow.	289	$7,080,692	2,046	$1,069,683	$8,761,857	$11,969,821
Grindstones.	25	903,348	1,167	407,153	263,811	1,088,909
Hairwork.	397	1,009,908	1,101	375,156	673,004	1,952,792
Hammocks.	13	308,254	339	101,626	242,950	480,114
Hand knit goods.	86	205,488	304	75,870	124,009	352,226
Hand stamps.	268	1,203,910	1,052	490,036	522,659	1,937,628
Hardware.	381	39,311,745	26,463	11,422,758	14,605,244	35,846,656
Hardware, saddlery.	80	3,335,274	2,940	1,217,202	1,690,168	4,149,489
Hat and cap materials.	70	1,744,419	1,371	434,148	2,797,756	3,849,116
Hats and caps, not including wool hats.	816	25,095,798	31,425	14,144,552	24,421,052	49,205,667
Hones and whetstones.	18	216,836	189	72,879	64,278	196,323
Hooks and eyes.	9	1,382,394	300	127,518	255,427	499,543
Horseshoes, factory product.	6	344,151	167	90,527	172,237	387,619
Hosiery and knit goods.	921	81,860,604	83,387	24,358,627	51,071,859	95,482,566
House furnishing goods, not elsewhere specified.	210	10,638,248	5,212	1,837,552	9,198,803	14,280,575
Ice, manufact'd.	775	38,019,507	6,880	3,402,745	3,312,393	13,780,978
Ink.	104	3,821,514	787	412,140	2,109,142	4,372,707
Instruments, professional and scientific.	265	4,491,627	2,786	1,433,715	1,385,292	4,896,631
Iron and steel.	668	573,391,663	222,490	120,820,276	522,398,932	803,968,273
Iron and steel, bolts, nuts, washers, and rivets.	72	10,799,692	7,660	2,991,857	8,071,071	13,978,382
Iron and steel, doors and shutters.	13	261,958	117	85,683	115,718	319,629
Iron and steel, forgings.	91	9,677,193	4,688	2,559,433	5,213,550	10,439,742
Iron and steel, nails and spikes, cut and wrought, including wire nails.	102	10,751,359	4,477	2,042,250	8,561,571	14,777,299
Iron and steel, pipe, wrought.	19	18,343,977	5,536	2,495,898	15,523,858	21,292,043
Ironwork, architectural and ornamental.	672	33,062,409	20,646	11,111,226	31,140,636	53,508,179
Ivory and bone work.	70	939,714	1,334	529,051	930,224	1,873,357
Japanning.	38	117,639	160	75,453	55,305	215,506
Jewelry.	908	28,120,939	20,676	10,746,375	22,356,067	46,501,181
Jewelry and instrument cases.	63	547,753	819	322,566	435,717	1,156,977
Jute and jute goods.	18	7,027,293	4,506	1,181,790	3,015,362	5,383,797
Kaolin and other earth grinding.	145	12,212,341	2,094	820,678	1,651,335	3,722,151
Kindling wood.	85	1,775,272	1,525	566,635	735,844	1,784,690
Labels and tags.	47	848,115	754	289,273	387,517	1,104,652
Lamps and reflectors.	156	6,375,474	4,725	2,076,980	3,497,236	8,341,374
Lapidary work.	60	3,087,390	498	498,715	4,655,765	5,786,281
Lard, refined.	19	1,335,759	499	237,930	7,496,845	8,630,901
Lasts.	65	1,484,966	1,131	649,654	526,670	1,879,742
Lead, bar, pipe, and sheet.	34	3,949,330	605	321,598	6,279,497	7,477,824

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners.		Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
			Average Number.	Total Wages.		
Lead, smelting and refining	39	$72,148,933	8,319	$5,088,684	$144,195,163	$175,466,304
Leather board	3	49,500	71	24,350	49,451	108,734
Leather goods	313	5,467,294	6,253	2,256,280	6,162,148	11,717,401
Leather, tanned, curried, and finished	1,306	173,977,421	52,109	22,591,091	155,000,004	204,038,127
Lime and cement	1,000	48,833,730	19,107	7,749,815	11,041,577	28,689,135
Linen goods	18	5,688,999	3,283	1,036,839	2,550,517	4,368,159
Liquors, distilled	967	32,551,604	3,722	1,733,218	15,147,784	96,798,443
Liquors, malt	1,509	415,284,468	39,532	25,826,211	51,674,928	237,269,713
Liquors, vinous	359	9,838,015	1,163	446,055	3,689,330	6,547,310
Lithographing and engraving	263	22,676,142	12,994	6,882,168	7 886,045	22,240,679
Lock and gunsmithing	2,103	2,250,300	1,553	769,351	929,700	3,703,127
Looking-glass and picture frames	1,629	7,747,382	7,712	3,370,072	6,887,331	15,570,293
Lumber and timber products	33,010	611,429,574	283,179	104,563,603	317,832,865	566,621,755
Lumber, planing mill products, including sash, doors, and blinds	4,204	119,271,631	73,627	32,685,210	99,927,707	168,343,003
Malt	146	39,288,102	1,990	1,182,513	14,816,741	19,373,600
Mantels, slate, marble, and marbleized	36	811,995	449	291,050	487,965	1,153,540
Marble and stone work	6,070	67,509,533	54,370	28,663,241	30,443,297	85,101,591
Masonry, brick and stone	8,333	48,070,239	93,568	53,152,258	87,280,964	203,593,634
Matches	22	3,893,000	2,047	612,715	3,420,740	6,005,937
Mats and matting	9	994,155	1,197	237,282	516,137	1,165,330
Mattresses and spring beds	797	8,298,772	7,959	3,213,268	10,444,009	18,463,704
Millinery and lace goods	591	10,764,813	16,871	5,817,855	15,654,295	29,469,406
Millinery, custom work	16,151	27,740,386	33,298	9,570,536	36,455,043	70,363,752
Millstones	3	49,238	37	20,957	30,995	75,922
Mineral and soda waters	2,816	20,518,708	8,985	4,169,113	8,801,467	23,874,429
Mirrors	103	3,184,426	2,555	1,231,689	4,995,671	8,004,301
Models and patterns	532	2,250,484	2,608	1,565,728	825,111	3,836,518
Mucilage & paste	117	1,265,426	480	205,082	1,657,342	2,629,299
Musical instruments and materials, not specified	229	3,896,101	2,405	1,232,039	1,205,337	3,394,734
Musical instruments, organs, and materials	129	5,011,987	3,435	1,720,727	2,220,165	5,691,504
Musical instruments, pianos and materials	261	38,790,494	17,869	9,818,996	15,147,520	35,324,090
Needles and pins	43	3,235,158	2,353	939,846	972,570	2,738,439
Nets and seines	19	1,160,782	748	222,146	865,908	1,476,022
Oakum	7	416,199	171	51,343	283,862	440,237
Oil, castor	3	539,221	49	29,068	293,408	395,400
Oil, cotton seed and cake	369	34,451,461	11,007	3,143,459	45,165,823	58,726,632
Oil, essential	70	612,657	199	69,100	596,112	850,093
Oil, lard	7	369,773	78	42,205	971,647	1,221,841
Oil, linseed	48	15,460,512	1,328	693,311	24,395,775	27,184,331
Oil, not elsewhere specified	193	9,441,984	1,353	679,730	9,807,859	17,089,799

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners. Average Number.	Wage-earners. Total Wages.	Cost of Materials Used.	Value of Products, Including Custom Work and Repairing.
Oil, resin	8	$284,110	90	$53,596	$535,320	$738,680
Oilcloth, enamel'd	9	1,702,904	512	300,878	2,696,412	3,595,515
Oilcloth, floor	18	7,176,198	2,718	1,327,235	4,853,260	7,807,105
Oleomargarine	24	3,023,646	1,084	534,444	7,639,501	12,499,812
Optical goods	350	5,567,809	4,341	1,935,219	3,233,430	7,790,970
Ordnance and ordnance stores	4	3,468,713	989	615,280	802,706	2,239,797
Oysters, canning and preserving	39	1,240,696	2,779	630,016	2,608,757	3,670,134
Painting and paper hanging	16,939	27,217,086	59,191	34,822,819	26,304,784	88,396,852
Paints	419	42,501,782	8,151	3,929,787	33,799,386	50,874,995
Paper and wood pulp	763	167,507,713	49,646	20,746,426	70,530,236	127,326,162
Paper goods, not elsewhere specified	190	11,370,585	6,117	2,242,702	9,819,820	16,785,269
Paper hangings	51	8,889,794	4,172	2,074,138	6,072,809	10,663,209
Paper patterns	16	256,075	836	262,559	124,854	563,653
Patent medicines and compounds	2,026	37,209,793	11,809	4,407,988	18,185,513	59,611,335
Paving and paving materials	1,729	37,888,412	34,090	14,570,408	20,152,477	46,447,719
Pencils, lead	7	2,227,406	2,162	683,281	1,030,917	2,222,276
Pens, fountain and stylographic	23	590,629	318	141,012	351,932	906,454
Pens, gold	22	496,246	378	229,679	312,537	799,078
Pens, steel	3	357,460	473	138,433	52,466	294,340
Perfumery and cosmetics	266	3,499,168	1,768	569,286	3,136,853	7,095,713
Petroleum refining	67	95,327,892	12,199	6,717,087	102,859,341	123,929,384
Phonographs and graphophones	11	3,348,282	1,267	608,490	827,529	2,246,274
Photographic apparatus	48	1,849,724	1,961	779,890	595,925	2,026,063
Photographic materials	105	3,668,026	1,483	662,958	2,782,285	5,773,325
Photography	7,553	13,193,589	8,911	4,013,018	6,841,853	23,238,719
Photolithographing and photo-engraving	204	1,999,921	2,698	1,756,578	728,743	4,226,106
Pickles, preserves, and sauces	474	10,656,854	6,812	2,161,962	12,422,432	21,507,046
Pipes, tobacco	98	1,111,144	1,585	737,647	1,106,299	2,471,908
Plated and britannia ware	66	16,486,471	6,392	3,088,224	5,875,312	12,608,770
Plumbers' supplies	174	13,598,528	8,024	3,930,594	7,289,867	14,771,185
Plumbing, and gas and steam fitti'g	11,876	47,111,264	53,916	31,873,866	65,334,689	131,852,567
Pocketbooks	68	991,876	1,653	588,595	1,278,226	2,495,188
Pottery, terra cotta, and fire-clay products	1,000	65,951,885	43,714	17,691,737	11,915,236	44,263,386
Printing and publishing	22,312	292,517,072	162,992	84,249,954	86,856,290	347,055 050
Printing materials	70	905,603	560	232,799	406,357	1,088,432
Pulp, from fiber other than wood	3	479,158	121	28,462	42,204	103,204
Pulp goods	22	2,316,985	691	283,835	646,639	1,267,013
Pumps, not including steam pumps	130	1,260,710	632	247,193	637,768	1,341,713
Refrigerators	95	4,782,110	3,329	1,287,488	2,476,518	5,317,886
Regalia and society banners and emblems	120	1,795,858	1,586	476,580	1,608,415	3,077,945
Registers, car fare	5	104,408	52	25,775	17,403	80,865

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners. Average Number.	Wage-earners. Total Wages.	Cost of materials Used.	Value of Products, Including Custom Work and Repairing.
Registers, cash	13	$5,137,965	2,015	$1,223,966	$903,834	$5,594,500
Rice, cleaning and polishing	80	2,601,352	651	265,585	7,575,522	8,723,726
Roofing and roofing materials	2,162	17,594,162	15,362	6,996,810	14,624,759	29,916,592
Rubber and elastic goods	262	39,304,853	20,405	8,082,738	33,485,694	52,627,030
Rules, ivory and wood	11	202,724	213	66,732	72,657	207,757
Saddlery and harness	12,934	43,354,136	24,123	10,725,647	33,127,926	62,630,902
Safes and vaults	35	5,479,879	2,033	1,017,237	1,689,148	3,927,867
Salt	159	27,123,364	4,774	1,911,140	3,335,922	7,966,897
Sand and emery paper and cloth	9	1,372,307	274	144,183	681,240	1,175,895
Saws	96	8,508,487	3,215	1,692,757	2,600,217	6,443,748
Scales and balances	86	6,307,576	2,775	1,436,839	1,533,379	5,239,788
Screws	33	7,931,457	3,527	1,423,838	1,720,455	4,658,467
Sewing machine cases	7	1,333,341	2,653	1,065,180	1,533,880	2,815,142
Sewing machine repairing	396	331,433	310	154,036	220,537	710,123
Sewing machines and attachments	58	18,739,459	10,635	6,213,938	7,809,796	18,314,419
Shipbuilding	1,116	77,362,701	46,781	24,839,163	33,486,772	74,578,158
Shirts	986	20,312,412	38,492	11,425,101	23,662,317	49,022,845
Shoddy	105	5,272,929	1,926	748,948	4,875,192	6,730,974
Show cases	102	1,152,898	1,363	708,211	1,057,666	2,467,901
Silk and silk goods	483	81,082,201	65,416	20,982,194	62,406,665	107,256,258
Silversmithing	44	1,999,921	1,437	803,662	1,229,158	2,936,462
Silverware	59	12,142,008	4,376	2,639,480	4,554,487	10,569,121
Slaughtering and meat packing, not including retail butchering	1,134	190,706,927	69,441	33,923,253	686,860,891	790,252,586
Smelting and refining, not from the ore	61	5,200,523	983	532,068	5,899,935	7,784,695
Soap and candles	558	38,068,334	9,487	3,754,767	33,143,230	53,231,017
Soda water apparatus	30	4,202,452	963	549,939	997,436	3,015,493
Sporting goods	144	2,018,737	2,230	810,943	1,802,903	3,633,396
Springs, steel, car and carriage	48	4,684,278	2,102	1,061,006	3,024,656	5,690,499
Stamped ware	139	13,954,176	10,002	3,730,241	7,333,028	14,546,191
Starch	124	11,671,567	2,655	1,099,696	5,806,422	9,232,984
Stationery goods, not elsewhere specified	113	4,494,507	3,032	958,471	2,128,445	5,065,869
Steam fittings and heating apparatus	227	18,233,173	9,252	4,982,857	10,219,506	22,084,860
Steam packing	97	2,691,304	1,147	525,332	1,546,398	3,493,710
Stencils and brands	92	532,528	418	206,231	140,711	673,784
Stereotyping and electrotyping	140	2,389,215	2,408	1,458,977	766,603	3,772,025
Straw goods, not elsewhere specified	4	25,070	54	14,381	12,933	36,985
Sugar and molasses, beet	30	20,141,719	1,970	1,092,207	4,803,796	7,323,857
Sugar and molasses, refining	832	184,245,519	14,262	6,945,811	222,503,741	240,969,905
Surgical applianc's	219	2,487,494	1,539	620,801	1,291,580	3,932,358
Taxidermy	147	366,077	180	91,140	177,038	513,112
Tin and terneplate	57	6,650,047	3,671	1,889,917	26,728,150	31,892,011

COMPARATIVE SUMMARY, BY SPECIFIED INDUSTRIES: 1900—*Continued.*

Industry.	Number of Establishments.	Capital.	Wage-earners. Average Number.	Wage-earners. Total Wages.	Cost of Materials Used.	Value of products, Including Custom Work and Repairing.
Tinfoil	15	$2,094,327	582	$227,774	$1,074,192	$1,593,169
Tinsmithing, coppersmithing, and sheet-iron working	12,466	55,703,509	45,575	22,155,039	50,329,282	100,310,720
Tobacco, chewing, smoking, and snuff	437	43,856,570	29,161	7,109,821	35,038,287	103,754,362
Tobacco, cigars and cigarettes	14,539	67,706,493	103,462	40,925,596	57,946,020	160,223,152
Tobacco, stemming and rehandling	276	12,526,808	9,654	1,817,067	14,198,349	19,099,032
Tools, not elsewhere specified	448	13,690,047	7,615	3,781,763	4,657,200	13,360,920
Toys and games	170	3,289,445	3,330	1,123,593	1,668,199	4,024,999
Trunks and valises	391	7,046,649	7,084	2,834,892	6,045,387	12,693,225
Turpentine and rosin	1,503	11,847,495	41,864	8,393,483	6,186,492	20,344,888
Type founding	22	2,269,370	1,424	803,470	863,689	2,842,384
Typewriter repairing	85	134,123	185	116,220	110,603	367,176
Typewriters and supplies	47	8,400,431	4,340	2,403,604	1,402,170	6,932,029
Umbrellas and canes	261	4,677,917	5,695	1,889,673	8,457,167	13,855,908
Upholstering materials	270	7,593,598	5,098	1,715,073	5,881,621	10,048,164
Varnish	181	17,550,892	1,546	995,803	10,939,131	18,687,240
Vault lights and ventilators	14	120,750	138	81,184	140,719	338,111
Vinegar and cider	1,152	6,187,728	1,801	720,316	3,272,565	6,454,524
Washing machi'es and clothes wringers	118	2,404,569	1,509	548,707	2,174,762	3,735,243
Watch and clock materials	20	367,291	331	152,234	105,549	345,347
Watch cases	30	8,119,292	3,907	1,924,847	4,393,647	7,783,960
Watch, clock, and jewelry repairing	12,229	12,741,973	8,380	4,683,086	4,432,108	20,235,039
Watches	13	14,235,191	6,880	3,586,723	1,291,318	6,822,611
Whalebone and rattan	3	56,200	14	7,856	98,875	135,000
Wheelbarrows	15	513,467	321	127,398	180,036	454,441
Whips	60	1,893,703	1,287	478,176	1,278,324	2,734,471
Windmills	68	4,308,666	2,045	940,474	2,172,098	4,354,312
Window shades	207	5,507,842	2,012	871,532	6,046,062	8,868,259
Wire	29	4,242,173	1,603	859,645	7,014,319	9,421,238
Wirework, including wire rope and cable	597	16,374,629	9,255	3,934,525	10,858,229	19,942,882
Wood, preserving	21	1,229,746	478	205,105	1,825,355	2,395,748
Wood, turned and carved	1,171	10,278,418	11,569	4,375,345	5,835,492	14,338,503
Woodenware, not elsewhere specified	104	3,824,512	3,206	1,073,303	1,468,383	3,585,542
Wool hats	24	2,050,802	2,108	937,855	2,042,202	3,591,940
Wool pulling	31	944,715	475	247,950	53,975	531,287
Wool scouring	25	1,061,123	720	338,606	193,826	889,809
Woolen goods	1,035	124,386,262	68,893	24,757,006	71,011,956	118,430,158
Worsted goods	186	132,168,110	57,008	20,092,738	77,075,222	120,314,344
Zinc, smelting and refining	31	14,141,810	4,869	2,355,921	13,286,058	18,188,498
All other industries	4	447,959	132	58,661	299,339	503,449

INDUSTRY GROUPS RANKED BY CAPITAL, NUMBER OF WAGE-EARNERS, WAGES, AND GROSS AND NET VALUE OF PRODUCTS: 1900.

[Twelfth Census, Vol. VII, page clxiv, and Vol. VIII, page 18.]

Industry Group.	Number of Establishments.	Rank.	Capital.	Rank.	Average Number of Wage-earners.	Rank.
Total	512,191	......	$9,813,834,390	......	5,306,143	......
Food and kindred products	61,266	2	937,686,610	5	311,717	7
Textiles	30,048	4	1,366,604,058	2	1,029,910	1
Iron and steel and their products	13,896	11	1,528,979,076	1	733,968	2
Lumber and its remanufact'res.	47,054	3	945,934,565	4	546,872	4
Leather and its finished products	16,989	7	343,600,513	13	238,202	10
Paper and printing	26,747	6	557,610,887	6	297,551	8
Liquors and beverages	7,861	13	534,101,049	7	63,072	14
Chemicals and allied products	5,443	14	498,282,219	8	101,489	13
Clay, glass, and stone products.	14,809	10	350,902,367	12	244,987	9
Metals and metal products, other than iron and steel	16,305	8	410,646,057	9	190,757	11
Tobacco	15,252	9	124,089,871	14	142,277	12
Vehicles for land transportati'n	10,112	12	396,671,441	10	316,157	6
Shipbuilding	1,116	15	77,362,701	15	46,781	15
Miscellaneous industries	29,479	5	1,348,920,721	3	483,273	5
Hand trades	215,814	1	392,442,255	11	559,130	3

Industry Group.	Wages.	Rank.	Value of Products. Gross.	Rank.	Net.	Rank.
Total	$2,320,938,168	......	$13,000,149,159	......	$8,367,997,844	......
Food and kindred products.	128,667,428	8	2,273,880,874	1	1,750,811,817	1
Textiles	341,734,399	2	1,637,484,484	3	1,081,961,248	2
Iron and steel and their products	381,875,499	1	1,793,490,908	2	983,821,918	3
Lumber and its remanufactures	212,124,780	4	1,030,695,350	5	547,227,860	6
Leather and its finished products	99,759,885	10	583,731,046	9	329,614,996	11
Paper and printing	140,092,453	7	606,317,768	8	419,798,101	7
Liquors and beverages	36,946,557	14	425,504,167	12	349,157,618	10
Chemicals and allied products	43,850,282	13	552,797,877	10	372,538,857	8
Clay, glass, and stone products	109,022,582	9	293,564,235	13	245,447,118	14
Metals and metal products, other than iron and steel.	96,749,051	11	748,795,464	7	371,154,446	9
Tobacco	49,852,484	12	283,076,546	14	264,052,573	12
Vehicles for land transportation	164,559,022	6	508,524,510	11	250,622,377	13
Shipbuilding	24,839,163	15	74,578,158	15	42,492,518	15
Miscellaneous industries	202,746,162	5	1,004,092,294	6	638,191,538	5
Hand trades	288,118,421	3	1,183,615,478	4	721,104,859	4

BANK OF INDUSTRIES WITH PRODUCTS

[Twelfth Census, Vol. VII, page

Industry.	Number of Establishments.	Rank.	Capital.	Rank.
Iron and steel	668	41	$573,391,663	3
Slaughtering and meat packing, not including retail butchering	1,134	31	190,706,927	10
Foundry and machine shop products	9,324	15	665,058,245	1
Lumber and timber products	33,010	2	611,429,574	2
Flouring and grist mill products	25,258	4	218,714,104	9
Clothing, men's	28,014	3	173,034,543	13
Printing and publishing	22,312	5	292,517,072	8
Cotton manufactures	1,055	33	467,240,157	5
Carpentering	21,315	6	71,327,047	31
Woolen manufactures	1,414	28	310,179,749	7
Boots and shoes, factory product	1,600	26	101,795,233	21
Sugar and molasses, refining	832	37	184,245,519	11
Liquors, malt	1,509	27	415,284,468	6
Cars and general shop construction and repairs by steam railroad companies	1,295	30	119,473,042	16
Leather, tanned, curried, and finished	1,306	29	173,977,421	12
Masonry brick and stone	8,333	16	48,070,239	39
Bread and other bakery products	14,917	9	81,049,553	28
Lead, smelting and refining	39	55	72,148,933	30
Lumber, planing mill products, including sash, doors, and blinds	4,204	22	119,271,631	17
Copper, smelting and refining	47	54	53,063,395	37
Tobacco, cigars, and cigarettes	14,539	10	67,706,493	32
Clothing, women's, factory product	2,701	23	48,431,544	38
Furniture, including cabinetmaking, repairing, and upholstering	7,972	17	117,982,091	19
Plumbing, and gas and steam fitting	11,876	13	47,111,264	40
Cheese, butter, and condensed milk	9,355	14	36,508,015	47
Paper and wood pulp	763	38	167,507,713	14
Petroleum, refining	67	53	95,327,892	22
Carriages and wagons	7,632	18	118,187,838	18
Silk and silk goods	483	44	81,082,201	27
Cars, railroad and street, and repairs, not including establishments operated by steam railroad companies	193	52	106,721,188	20
Tobacco, chewing, smoking, and snuff	437	47	43,856,570	41
Agricultural implements	715	39	157,707,951	15
Tinsmithing, coppersmithing, and sheet-iron working	12,466	12	55,703,509	35
Liquors, distilled	967	34	32,551,604	51
Hosiery and knit goods	921	35	81,860,604	26
Electrical apparatus and supplies	580	42	83,130,943	24
Painting and paper hanging	16,939	7	27,217,086	55
Blacksmithing and wheelwrighting	51,771	1	54,976,341	36
Marble and stone work	6,070	19	67,509,533	33
Confectionery	4,297	21	35,155,361	48
Gas, illuminating and heating	877	36	567,000,506	4
Shipbuilding	1,116	32	77,362,701	29
Millinery, custom work	16,151	8	27,740,386	54
Coffee and spice, roasting and grinding	458	46	28,436,897	52
Chemicals	459	45	89,091,430	23
Saddlery and harness	12,934	11	43,354,136	42
Patent medicines and compounds	2,026	24	37,209,793	46
Oil, cottonseed and cake	369	49	34,451,461	49
Fruits and vegetables, canning and preserving	1,808	25	27,743,067	53
Glass	355	50	61,423,903	34
Ironwork, architectural and ornamental	672	40	33,062,409	50
Soap and candles	558	43	38,068,334	45
Rubber and elastic goods	262	51	39,304,853	44
Brick and tile	5,423	20	82,086,438	25
Paints	419	48	42,501,782	43

VALUED AT OVER $50,000,000: 1900.

clxiii, and Vol. VIII, page 18.]

Average Number of Wage-earners.	Rank.	Wages.	Rank.	Value of Products.			
				Net.	Rank.	Gross.	Rank.
222,490	4	$120,820,276	2	$432,687,119	3	$803,968,273	1
69,441	17	33,923,253	15	684,119,221	1	790,252,586	2
350,327	1	182,232,009	1	377,812,876	4	644,990,999	3
283,179	3	104,563,603	3	307,838,590	5	566,621,755	4
37,073	34	17,703,418	35	540,052,649	2	560,719,063	5
191,043	5	79,434,932	7	220,140,823	8	415,256,391	6
162,992	7	84,249,954	6	264,859,062	7	347,055,050	7
302,861	2	86,689,752	5	296,633,150	6	339,200,320	8
123,985	10	71,049,737	8	176,611,706	12	316,101,758	9
159,108	8	57,933,817	10	218,637,292	9	296,990,484	10
142,922	9	59,175,883	9	93,701,767	19	261,028,580	11
14,262	45	6,945,811	46	49,216,847	40	240,969,905	12
39,532	33	25,826,211	23	202,582,268	10	237,269,713	13
173,595	6	96,006,570	4	111,622,240	16	218,113,658	14
52,109	26	22,591,091	27	186,389,057	11	204,038,127	15
93,568	13	53,152,258	11	125,356,555	14	203,593,634	16
60,271	21	27,893,170	21	89,262,303	23	175,657,348	17
8,319	52	5,088,684	49	97,425,341	18	175,466,304	18
73,627	16	32,685,210	16	74,205,166	28	168,343,003	19
11,324	49	8,529,021	42	76,502,702	26	165,131,670	20
103,462	11	40,925,596	13	152,300,012	13	160,223,152	21
83,739	14	32,586,101	17	75,315,179	27	159,339,539	22
100,018	12	42,638,810	12	91,151,488	22	153,168,309	23
53,916	24	31,873,866	18	68,035,688	30	131,852,567	24
12,865	46	6,170,670	48	124,008,573	15	131,199,277	25
49,646	27	20,746,426	32	77,954,480	25	127,326,162	26
12,199	47	6,717,087	47	107,512,092	17	123,929,384	27
62,540	19	29,814,911	19	67,172,479	31	121,537,276	28
65,416	18	20,982,194	31	86,483,994	24	107,256,258	29
44,063	31	23,342,763	26	39,326,856	47	107,186,359	30
29,161	39	7,109,821	45	92,915,542	20	103,754,362	31
46,582	29	22,450,880	28	60,535,599	36	101,207,428	32
45,575	30	22,155,039	29	51,638,038	38	100,310,720	33
3,722	55	1,733,218	55	91,451,293	21	96,798,443	34
83,387	15	24,358,627	25	54,544,999	37	95,482,566	35
40,890	32	20,190,344	33	44,583,830	41	91,348,889	36
59,191	22	34,822,819	14	62,541,861	35	88,396,852	37
36,193	36	17,974,264	34	63,764,914	34	85,971,630	38
54,370	23	28,663,241	20	69,097,079	29	85,101,591	39
33,583	37	10,867,687	38	44,179,706	42	81,290,543	40
22,459	41	12,436,296	36	64,276,431	33	75,716,693	41
46,781	28	24,839,163	24	42,492,518	46	74,578,158	42
33,298	38	9,570,536	40	34,529,813	51	70,363,752	43
6,387	54	2,486,759	54	64,741,832	32	69,527,108	44
19,054	44	9,401,467	41	36,918,124	48	62,676,730	45
24,123	40	10,725,647	39	30,677,173	52	62,630,902	46
11,809	48	4,407,988	50	43,819,968	44	59,611,335	47
11,007	50	3,143,459	53	43,196,446	45	58,726,632	48
36,401	35	8,050,793	44	36,668,635	49	56,668,313	49
52,818	25	27,084,710	22	43,905,999	43	56,539,712	50
20,646	42	11,111,226	37	23,398,179	54	53,508,179	51
9,487	51	3,754,767	52	24,228,062	53	53,231,017	52
20,405	43	8,082,738	43	35,278,808	50	52,627,030	53
61,979	20	21,883,333	30	50,312,022	39	51,270,476	54
8,151	53	3,929,787	51	18,545,525	55	50,874,995	55

ESTABLISHMENTS AND PRODUCTS CLASSIFIED BY CHARACTER OF ORGANIZATION, BY GROUPS OF INDUSTRIES: 1900.*

[Twelfth Census, Vol. VII, pages lxvi and 503.]

Industry Group.	Character of Organization.			
	Total.		Individual.	
	Number of Establishments.	Value of Products.	Number of Establishments.	Value of Products.
Total	512,191	$13,000,149,159	372,692	$2,674,426,373
Food and kindred products	61,266	2,273,880,874	42,569	444,230,465
Textiles	30,048	1,637,484,484	18,701	262,342,066
Iron and steel and their products	13,896	1,793,490,908	5,717	107,343,147
Lumber and its remanufactures	47,054	1,030,695,350	28,463	265,781,468
Leather and its finished products	16,989	583,731,046	12,906	....
Paper and printing	26,747	606,317,768	16,392	127,110,593
Liquors and beverages	7,861	425,504,167	5,063	69,353,112
Chemicals and allied products	5,443	552,797,877	2,085	....
Clay, glass, and stone products	14,809	293,564,235	8,761	69,147,764
Metals and metal products, other than iron and steel	16,305	748,795,464	10,666	....
Tobacco	15,252	283,076 546	12,803	79,919,991
Vehicles for land transportation	10,112	508,524,510	5,750	43,223,011
Shipbuilding	1,116	74,578,158	748	12,592,136
Miscellaneous industries	29,479	1,004,092,294	18,545	173,848,128
Hand trades	215,814	1,183,615,478	183,523	777,274,319

Industry Group.	Character of Organization.					
	Firm and Limited Partnership.		Incorporated Company.		Cooperative and Miscellaneous.	
	Number of Establishments.	Value of Products.	Number of Establishments.	Value of Products.	Number of Establishments.	Value of Products.
Total	96,701	$2,565,242,473	40,705	$7,729,520,548	2,093	$30,959,765
Food and kindred products	11,905	394,387,619	4,994	1,410,298,055	1,798	24,964,735
Textiles	8,084	547,349,114	3,245	827,705,447	18	87,857
Iron and steel and their products	3,329	177,415,968	4,843	1,508,493,141	7	238,652
Lumber and its remanufact'res.	13,893	256,014,803	4,670	508,341,338	28	557,741
Leather and its finished products	2,990	208,571,042	1,091	257,808,524	2	....
Paper and printing	5,682	106,830,193	4,490	368,923,042	183	3,453,940
Liquors and beverages	1,463	....	1,333	305,129,467	2	....
Chemicals and allied products	1,152	60,181,725	2,205	450,008,084	1	....
Clay, glass, and stone products	3,891	66,327,320	2,132	157,336,458	25	752,693
Metal and metal products, other than iron and steel	4,167	88,143,271	1,470	578,172,577	2	....
Tobacco	2,085	74,456,334	358	128,478,983	6	221,238
Vehicles for land transportati'n	2,079	....	2,282	430,731,303	1	....
Shipbuilding	217	6,414,398	151	55,571,624	......	....
Miscellaneous industries	6,174	188,153,370	4,750	641,875,764	10	215,032
Hand trades	29,590	305,612,005	2,691	100,646,741	10	82,413

*In this table values have been omitted wherever they disclosed the products of individual establishments.

ESTABLISHMENTS CLASSIFIED BY NUMBER OF EMPLOYEES, NOT INCLUDING PROPRIETORS AND FIRM MEMBERS: 1900.

[Twelfth Census, Vol. VII, pages lxxiii and 582.]

Industry Group.	Total Number of Establishments.	Number of Establishments Reporting.								
		No. Employees.	Under 5.	5 to 20.	21 to 50.	51 to 100.	101 to 250.	251 to 500.	501 to 1000.	Over 1000.
Total	512,191	110,509	232,716	112,120	32,403	11,658	8,475	2,804	1,063	443
Food and kindred products	61,266	14,611	34,759	8,129	1,888	912	696	161	81	29
Textiles	30,048	1,300	11,036	9,722	3,458	1,828	1,620	669	295	120
Iron and steel and their products	13,896	783	3,102	4,349	2,186	1,395	1,244	513	221	103
Lumber and its remanufactures	47,054	2,069	16,836	20,039	4,814	1,892	1,128	218	51	7
Leather and its finished products	16,989	5,028	8,163	1,644	857	560	472	196	50	19
Paper and printing	26,747	2,400	12,628	7,962	2,139	874	565	143	30	6
Liquors and beverages	7,861	671	4,185	2,070	569	228	103	27	6	2
Chemicals and allied products	5,443	643	1,607	1,689	806	390	224	64	10	10
Clay, glass, and stone products	14,809	1,022	3,876	6,121	2,186	857	562	134	42	9
Metals and metal products, other than iron and steel	16,305	2,950	8,029	3,542	951	386	291	85	51	20
Tobacco	15,252	3,637	7,273	3,004	672	309	233	85	28	11
Vehicles for land transportation	10,112	1,183	3,772	3,080	829	467	416	229	88	48
Shipbuilding	1,116	198	211	361	152	83	56	29	17	9
Miscellaneous industries	29,479	5,191	10,403	8,026	3,123	1,477	865	251	93	50
Hand trades	215,814	68,823	[1] 106,836	[2] 32,382	[3] 7,773	....	....	....	....	....

[1] Includes establishments with 1 to 5 employees.
[2] Includes establishments with 6 to 20 employees.
[3] Includes establishments with over 20 employees.

AMERICAN IRRIGATION.

There are in the United States some 500,000,000 acres in what is known as the Arid Belt. These are not available for agriculture until they have been irrigated. "It is now estimated that at least 15,000,000 acres will be added to the available domain of the country during the first ten years" following the enactment of a new law, "while the authorities in charge of the work insist that under its operations it will be possible to bring into actual cultivation and use some years earlier than had been anticipated the 100,000 square miles included in the original estimate."

The new law referred to "repealed the previous enactment permitting single individuals to take up land to the amount of 160 acres under the Homestead timber culture and preemption systems, making 480 acres in all." It provided, among other things, that 160 acres should be the maximum. —London "Times," October 31, 1903.

POPULATION OF EUROPE.

The population of Europe has been carefully estimated at recent dates by MM. Levasseur and Bodio with these results:

YEAR.	POPULATION.
1900	401,098 000
1886	346,700,000
1880	331,000,000
1878	325,700,000
1860	289,000,000

—Daily Mail Year Book.

COST OF MATERIALS USED IN EACH OF THE FIFTEEN GROUPS OF INDUSTRIES: 1900.

[Twelfth Census, Vol. VII. page cxxxvii.]

Industry Group.	Cost of Materials Used.			Per Cent of Cost of Materials to Gross Value of Products.		Per Cent of Cost of Materials Purchased in Raw State of Net Value of Products.
	Purchased in Raw State.	Purchased in Partially Manufactured Form.	Fuel, Freight, etc.	Purchased in Partially Manufactured Form.	Purchased in Raw State.	
Total	$2,389,138,828	$4,632,151,315	$322,337,732	35.6	18.4	28.6
Food and kindred products	1,279,450,388	523,069,057	35,148,815	23.0	56.3	73.0
Textiles	314,089,230	555,523,236	26,372,330	33.9	19.2	29.0
Iron and steel and their products	74,781,646	809,668,990	102,747,734	45.1	4.2	7.6
Lumber and its remanufactures	64,502,232	483,467,490	13,440,897	46.9	6.3	11.8
Leather and its finished products	134,809,625	254,116,050	6,625,557	43.5	23.1	40.9
Paper and printing	11,396,844	186,519,667	16,241,912	30.8	1.9	2.7
Liquor and beverages	37,340,408	76,346,549	8,531,116	17.9	8.8	10.7
Chemicals and allied products	154,470,332	180,259,020	21,422,432	32.6	27.9	41.5
Clay, glass, and stone products	18,971,906	48,117,117	27,526,258	16.4	6.5	7.7
Metals and metal products, other than iron and steel	98,737,311	377,641,018	20,601,039	50.4	13.2	26.6
Tobacco	86,709,511	19,023,973	1,449,172	6.7	30.6	32.8
Vehicles for land transportation	1,342,802	257,902,133	8,966,610	50.7	0.3	0.5
Shipbuilding	....	32,085,640	1,401,132	43.0	....	....
Miscellaneous industries	103,685,431	365,900,756	20,487,518	36.4	10.3	16.2
Hand trades	8,851,162	462,510,619	11,375,210	39.1	0.7	1.2

TOURISTS IN SWITZERLAND.

The following figures with regard to tourists in Switzerland have been compiled by Herr Freuler, of Zurich.

Money paid annually by visitors to hotel proprietors—between $15,000,000 and $20,000,000; paid to railway companies, etc., $3.375,000; gross profit is estimated at $12,375,000, from which $8,000 has to be taken for depreciation and improvements. The capital outlay is estimated at $120,000,000.

There are some 1,896 hotels and pensions, etc., with 104,800 beds; 945 are only open in the season, 951 are open all the year, 22,000 people find regular employment in these hotels, and 5,000 irregularly, with wages totaling 9 to 11 million francs and gratuities amounting to 3 1-2 to 4 million francs.—"Daily Mail" Year Book.

JURA TUNNEL.

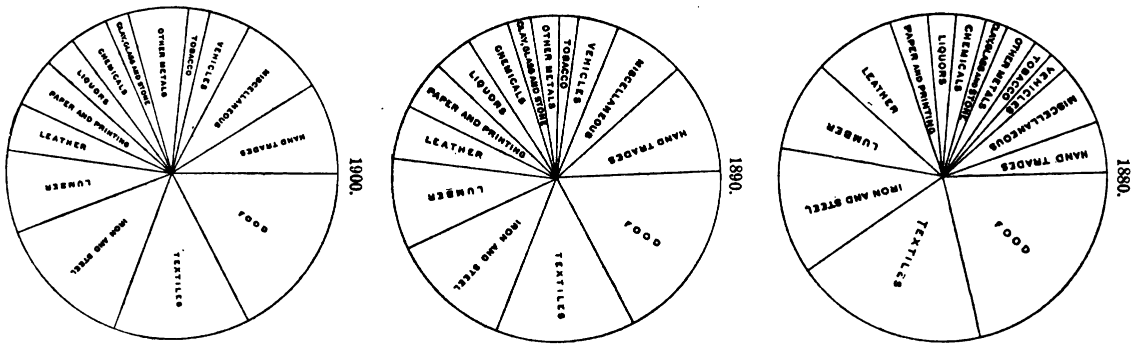
The Grand Council of the Canton of Berne, in the year 1903, agreed to grant a subvention for the construction of the projected Jura Tunnel for a line between Soleure and Munster, which will give access to the proposed tunnel through the Bernese Alps for communication with the Simplon Tunnel. An agreement has also been arrived at between the Federal Council and the Simplon Tunnel Company by which the latter will receive an increased amount for the construction of the Simplon Tunnel, but will not be liberated from its obligation to construct a second tunnel. The company agrees to transfer the tunnel to the Federal Government.

VALUES OF DOMESTIC MERCHANDISE EXPORTED, GROUPED ACCORDING TO SOURCES OF PRODUCTION.

Year ending June 30	Exports of Domestic Merchandise other than Manufactures.[1]												Exports of Domestic Manufactures.		Total Exports of Domestic Merchandise.
	Agriculture.		Mining.		Forest.		Fisheries.		Miscellaneous.		Total.				
	Values.	P. Ct.	Values.	P. Ct.	Values.	P. Ct.	Values.	P. Ct.	Values.	P. Ct.	Values.	P. Ct.	Values.	P. Ct.	Values.
	Dollars.		Dollars.		Dollars.		Dollars.		Dollars.		Dollars.		Dollars.		Dollars.
1860	256,560,972	81.13	999,465	0.31	10,299,959	3.26	4,156,480	1.31	3,879,655	1.23	275,896,531	87.24	40,345,892	12.76	316,242,423
1870	361,188,483	79.35	5,026,111	1.10	14,897,963	3.27	2,835,508	.62	2,980,512	.66	386,928,577	85	68,279,764	15	455,208,341
1880	685,961,091	83.25	5,863,232	.71	17,321,268	2.11	5,255,402	.64	6,689,345	.81	721,090,338	87.52	102,856,015	12.48	823,946,353
1890	629,820,808	74.51	22,297,755	2.64	29,473,084	3.49	7,458,385	.88	5,141,420	.61	694,191,452	82.13	151,102,376	17.87	845,293,828
1900	835,858,123	60.98	37,843,742	2.76	52,218,112	3.81	6,326,620	.46	4,665,218	.34	936,911,815	68.35	433,851,756	31.65	1,370,763,571
1903	873,322,882	62.73	39,311,239	2.81	57,835,896	4.16	7,805,538	.56	6,429,588	.46	984,705,143	70.72	407,526,159	29.28	1,392,231,302

[1] The group "Other than Manufactures" embraces substantially all articles crude or only slightly enhanced in value by manufacture.

—Statistical Abstract of the United States.



DIVISION OF INDUSTRIES. — SEGMENTS ARE BASED ON PRODUCTION IN THE CENSUS YEAR 1890.

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE DURING THE YEAR ENDING JUNE 30, 1903.

(Bureau of Statistics).

Articles.		Quantities.	Values.
Agricultural Implements:			Dollars.
Mowers and reapers, and parts of			10,326,641
Plows and cultivators, and parts of			3,169,961
All other, and parts of			7,510,020
Total			21,006,622
Aluminum, and manufactures of			133,256
Animals:			
Cattle	No.	402,178	29,848,936
Hogs	No.	4,031	40,923
Horses	No.	34,007	3,152,159
Mules	No.	4,294	521,725
Sheep	No.	176,961	1,067,860
All other, including fowls			149,590
Total			34,781,193
Art works: Paintings and statuary			512,558
Asbestos, and manufactures of			133,427
Asphaltum, and manufactures of			104,586
Babbitt metal			44,635
Bark, and extract of, for tanning			239,786
Beeswax	lbs.	70,811	21,337
Billiard balls			4,228
Bird skins			650
Blacking:			
Stove polish			198,152
All other			511,136
Bones, hoofs, horns, and horn tips, strips, and waste			193,817
Books, maps, engravings, etchings, and other printed matter			4,442,653
Brass, and manufactures of			2,000,432
Breadstuffs:			
Barley	bush.	8,429,141	4,662,544
Bread and biscuit	lbs.	11,104,575	589,536
Buckwheat	bush.	117,953	75,713
Corn	bush.	74,833,237	40,540,637
Corn meal	bbls.	451,506	1,382,127
Oats	bush.	4,613,809	1,850,728
Oatmeal	lbs.	67,823,935	1,839,106
Rye	bush.	5,422,731	3,143,910
Rye flour	bbls.	3,757	12,818
Wheat	bush.	114,181,420	87,795,104
Wheat flour	bbls.	19,716,484	73,756,404
Preparations of, for table food			2,667,409
All other, for animal feed—			
Bran, middlings, and mill feed	tons.	49,513	945,053
Dried grains and malt sprouts	tons.	73,104	1,320,065
All other			661,131
Total			221,242,285
Bricks:			
Building	M.	3,725	26,310
Fire			403,598
Total			429,908
Bristles			515
Broom corn			211,253
Brooms and brushes			283,994
Candles	lbs.	6,323,554	514,753
Carbon			44,494

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
CARRIAGES, CARS, OTHER VEHICLES, AND PARTS OF:		Dollars.
Automobiles, and parts of		1,207,065
Cars, passenger and freight, and parts of—		
For steam railways		2,687,303
For other railways		915,273
Cycles, and parts of		2,132,629
All other carriages and parts of		3,556,925
Total		10,499,195
Celluloid, and manufactures of		249,488
Cement ... bbls.	271,272	419,361
Chalk, crayons, etc		37,238
Charcoal		5,118
Chewing gum		27,242
CHEMICALS, DRUGS, DYES, AND MEDICINES:		
Acids		219,568
Ashes, pot and pearl ... lbs.	1,193,258	60,376
Baking powder ... lbs.	1,178,540	397,965
Copper, sulphate of ... lbs.	18,101,320	736,137
Dyes and dyestuffs		619,645
Ginseng ... lbs.	151,985	796,008
Lime, acetate of ... lbs.	59,449,811	987,067
Medicines, patent or proprietary		3,407,696
Roots, herbs, and barks, not elsewhere specified		320,122
Washing powders or mixtures, etc ... lbs.	6,322,357	352,537
All other		5,800,480
Total		13,697,601
Cider ... galls.	598,119	84,084
CLAYS:		
Fire		4,402
All other		149,897
CLOCKS AND WATCHES:		
Clocks, and parts of		1,091,724
Watches, and parts of		1,041,805
Total		2,133,529
COAL AND COKE:		
Coal—		
Anthracite ... tons.	1,388,653	6,732,571
Bituminous ... tons.	5,210,322	14,473,927
Total coal	6,598,975	21,206,498
Coke ... tons.	380,038	1,912,459
Coal tar ... bbls.	4,834	15,531
Cocoa, ground or prepared, and chocolate		213,476
COFFEE:		
Raw or green ... lbs.	29,233,837	3,295,968
Roasted or prepared ... lbs.	535,108	89,899
COINS, UNITED STATES:		
Copper		41
Nickel		2,650
COPPER AND MANUFACTURES OF:		
Ore ... tons.	12,868	927,417
Ingots, bars, plates, and old ... lbs.	297,056,122	37,354,061
All other manufactures of		2,313,135
Total, not including ore		39,667,196
Copper residue ... lbs.	522,280	42,385
Cork, manufactures of		33,844

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
COTTON, AND MANUFACTURES OF:		Dollars.
Unmanufactured—		
Sea Island ... bales...	51,688	4,038,370
lbs. ...	20,205,080	
Upland and other ... bales...	6,886,591	312,142,059
lbs. ...	3,522,837,942	
Total unmanufactured ... bales...	6,938,279	316,180,429
lbs. ...	3,543,043,022	
Waste ... lbs...	26,098,947	884,842
Manufactures of—		
Cloths—		
Colored ... yds...	169,511,667	8,443,148
Uncolored ... yds...	325,867,530	16,909,436
Total cloths ...	495,379,197	25,352,584
Wearing apparel ...	...	2,600,136
Waste, cop and mill ... lbs...	22,997,428	1,294,064
All other ...	...	2,969,520
Total manufactures ...	...	32,216,304
Curios, antiques, etc. ...	...	1,698
Dental goods ...	...	401,761
EARTHEN, STONE, AND CHINA WARE:		
Earthen and stone ware ...	...	519,159
China ware ...	...	63,900
Total ...	...	583,059
Eggs ... doz...	1,517,189	325,571
Egg yolks ...	...	48,108
EMERY, AND MANUFACTURES OF:		
Emery ...	...	19,975
Manufactures of—		
Cloth ...	...	9,654
Paper ...	...	1,389
Wheels ...	...	216,345
Feathers ...	...	141,257
FERTILIZERS:		
Phosphates, crude ... tons...	817,503	6,344,224
All other ... tons...	16,677	380,077
FIBRES, VEGETABLE, AND TEXTILE GRASSES, MANUFACTURES OF:		
Bags ...	...	387,840
Cordage ... lbs...	9,119,620	935,587
Twine ...	...	3,331,101
All other ...	...	636,420
Total ...	...	5,290,948
FISH:		
Fresh, other than salmon ... lbs...	1,568,753	60,692
Dried, smoked, or cured—		
Cod, haddock, hake, and pollock ... lbs...	3,043,497	148,557
Herring ... lbs...	1,202,680	33,632
All other ... lbs...	467,525	23,020
Pickled—		
Mackerel ... bbls...	524	7,360
All other ... bbls...	19,167	74,346
Salmon—		
Canned ... lbs...	59,353,334	4,350,791
All other, fresh or cured ...	...	869,352
Canned fish, other than salmon and shellfish ...	...	105,228
Caviare ...	...	39,278

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
FISH—(*Continued*).		
Shellfish—		Dollars.
Oysters		630,935
All other		296,307
All other fish and fish products		77,776
Total		6,717,274
Flowers, cut		5,290
Fly paper		38,579
FRUITS AND NUTS:		
Fruits—		
Apples, dried ... lbs	39,646,297	2,378,635
Apples, green or ripe ... bbls	1,656,129	4,381,801
Apricots, dried ... lbs	9,190,081	713,887
Oranges		465,397
Prunes ... lbs	66,385,215	3,512,507
Raisins ... lbs	4,280,028	284,530
All other green, ripe, or dried		4,215,034
Preserved—		
Canned		1,739,571
All other		66,757
Nuts		299,558
Total		18,057,677
Furniture of metal		124,856
Furs and fur skins		6,188,115
Ginger ale ... doz. qts	1,501	1,911
GLASS AND GLASSWARE:		
Window glass		59,519
All other		2,091,180
Total		2,150,699
Glucose or grape sugar ... lbs	126,239,981	2,460,022
Glue ... lbs	2,569,164	253,768
Goldbeaters' skins		1 140
Graphite		12,246
Grasses, dried (Pampas plumes, etc.)		15,294
Grease, grease scraps, and all soap stock		2,926,565
GUNPOWDER AND OTHER EXPLOSIVES:		
Gunpowder ... lbs	1,112,490	151,658
All other explosives		2,302,852
Total		2,454,510
Hair, and manufactures of		616,133
Hay ... tons	50,974	828,483
Hides and skins, other than furs ... lbs	12,859,549	1,224,409
Honey		64,220
Hops ... lbs	7,794,705	1,909,951
Household and personal effects		2,652,783
Ice ... tons	19,626	41,073
INDIA RUBBER, MANUFACTURES OF:		
India rubber, reclaimed		93,265
India rubber, scrap and old		404,586
Belting, hose, and packing		819,985
Boots and shoes ... pairs	2,307,401	1,056,491
All other		2,299,875
Total		4,674,202
INK:		
Printers'		220,544
All other		138,103

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
INSTRUMENTS AND APPARATUS FOR SCIENTIFIC PURPOSES:		
Electrical appliances, including telegraph and telephone instruments		Dollars. 4,206,617
All other		2,923,891
IRON AND STEEL, AND MANUFACTURES OF:		
Iron ore ... tons	77,220	266,982
Pig iron—		
Ferro-manganese ... tons; All other ... tons	18,198	362,068
Scrap and old, fit only for remanufacture ... tons	6,043	96,107
Bar Iron ... lbs	40,583,205	721,284
Bars or rods of steel—		
Wire rods ... lbs	71,360,171	1,059,130
All other ... lbs	30,447,664	802,173
Billets, ingots, and blooms ... tons	2,127	68,064
Hoop, band, and scroll ... lbs	3,740,234	78,745
Rails for railways—		
Iron ... tons	81	3,154
Steel ... tons	22,896	710,886
Sheets and plates—		
Iron ... lbs	6,491,690	191,332
Steel ... lbs	31,680,206	734,151
Tin plates, terne plates, and taggers tin ... lbs	1,555,146	66,010
Structural iron and steel ... tons	32,952	1,963,797
Wire ... lbs	224,153,085	5,172,140
Builders' hardware, saws, and tools—		
Locks, hinges, and other builders' hardware		7,461,594
Saws		413,679
Tools, not elsewhere specified		4,189,551
Car wheels ... No	22,106	156,601
Castings, not elsewhere specified		1,916,091
Cutlery—		
Table		69,848
All other		253,662
Firearms		1,002,410
Machinery, machines, and parts of—		
Cash registers ... No	16,786	1,475,199
Electrical machinery		5,779,459
Laundry machinery		512,108
Metal working machinery		2,826,111
Printing presses, and parts of		1,050,773
Pumps and pumping machinery		2,715,553
Sewing machines, and parts of		5,105,852
Shoe machinery		719,797
Steam engines, and parts of—		
Fire ... No	10	19,650
Locomotive ... No	289	3,219,778
Stationary ... No	1,459	725,294
Boilers, and parts of engines		2,485,226
Typewriting machines, and parts of		3,966,741
All other		20,387,065
Nails and spikes—		
Cut ... lbs	16,129,436	347,007
Wire ... lbs	62,997,105	1,245,946
All other, including tacks ... lbs	5,556,014	290,862
Pipes and fittings		5,431,459
Safes ... No	2,933	184,706
Scales and balances		650,250
Stoves, ranges, and parts of		961,562
All other manufactures of iron and steel		9,048,992
Total, not including ore		96,642,467
Ivory, manufactures of, and scrap		68,816
Jewelers' ashes and sweepings		174,158
JEWELRY, AND OTHER MANUFACTURES OF GOLD AND SILVER:		
Jewelry		939,797
All other manufactures of gold and silver		353,224
Lamps, chandeliers, and all other devices for illuminating purposes		1,133,290

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
LEAD, AND MANUFACTURES OF:		Dollars.
Pigs, bars, and old. . . lbs.	308,807	15,527
Type . . . lbs.	407,647	137,875
All other manufactures of.		299,300
LEATHER, AND MANUFACTURES OF:		
Sole leather . . . lbs.	37,428,437	6,920,467
Upper leather—		
Kid, glazed		1,995,200
Patent or enameled.		122,782
Splits, buff, grain, and all other upper.		13,493,499
All other leather.		982,251
Manufactures of—		
Boots and shoes. . . pairs.	4,197,566	6,665,017
Harness and saddles.		373,677
All other.		1,064,496
Total.		31,617,389
Lime. . . bbls.	39,658	32,694
Malt. . . bush.	347,147	252,801
MARBLE AND STONE, AND MANUFACTURES OF:		
Unmanufactured.		194,879
Manufactures of—		
Roofing slate.		628,612
All other.		641,753
Total.		1,465,244
Matches.		56,330
Metal polish.		32,274
Mica.		4,615
Mineral specimens.		10,306
Moss and seaweeds.		46,499
Mucilage.		12,563
MUSICAL INSTRUMENTS:		
Organs. . . No.	15,986	1,137,713
Pianofortes. . . No.	2,019	419,029
All other, and parts of.		1,824,767
Total.		3,381,509
Natural history specimens.		13,119
NAVAL STORES:		
Rosin. . . bbls.	2,396,498	4,817,052
Tar. . . bbls.	18,622	50,802
Turpentine and pitch. . . bbls	15,972	36,379
Turpentine, spirits of . . . galls.	16,378,787	8,014.322
Total.		12,918,708
NICKEL:		
Oxide and matte. . . lbs.	2,997,400	864,221
Manufactures of.		97,787
Notions, not elsewhere specified.		186,653
Nursery stock.		158,959
Oakum.		26,740
OIL CAKE AND OIL-CAKE MEAL:		
Corn-oil cake. . . lbs.	8,093,222	95,568
Cotton-seed. . . lbs.	1,100,392,988	12,732,497
Flaxseed or linseed. . . lbs.	570,908,149	7,011,214
Total.	1,679,394,359	19,839,279
OILCLOTHS:		
For floors.		56,902
All other.		164,515

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
OILS:		
Animal—		Dollars.
Fish. . . . galls. . .	1,293,393	377,551
Lard. . . . galls. . .	356,658	306,334
Whale. . . . galls. . .	19,092	13,174
All other. . . . galls. . .	221,669	159,505
Total animal. . . .	1,890,812	856,564
Mineral, crude, including all natural oils, without regard to gravity. . . . galls. . .	134,892,170	6,329,899
Mineral, refined or manufactured—		
Naphthas, including all lighter products of distillation. galls. . .	13,139,228	1,225,661
Illuminating. . . . galls. . .	699,807,201	47,078,931
Lubricating, and heavy paraffin. . . . galls. . .	93,318,257	12,052,927
Residuum, including tar, and all other, from which the light bodies have been distilled. . . . bbls. . .	542,893	566,115
Total refined or manufactured. . . .	. . . .	60,923,634
Vegetable—		
Corn. . . . galls. . .	3,788,035	1,467,493
Cotton seed. . . . galls. . .	35,642,994	14,211,244
Linseed. . . . galls. . .	182,330	98,116
Volatile or essential—		
Peppermint. . . . lbs. . .	13,033	34,943
All other. . . .	. . . .	252,770
All other vegetable. . . .	. . . .	169,796
Total vegetable. . . .	. . . .	16,234,362
PAINTS, PIGMENTS, AND COLORS:		
Carbon black, gas black, and lamp black. . . .	. . . .	299,587
Zinc, oxide of. . . . lbs. . .	11,091,960	446,786
All other. . . .	. . . .	1,604,564
Total. . . .	. . . .	2,350,937
PAPER, AND MANUFACTURES OF:		
Paper hangings. . . .	. . . .	256,243
Printing paper. . . . lbs. . .	97,880,037	2,613,117
Writing paper and envelopes. . . .	. . . .	901,700
All other. . . .	. . . .	3,408,954
Total. . . .	. . . .	7,180,014
Paraffin and paraffin wax. . . . lbs. . .	201,325,210	9,411,294
Paste. . . .	. . . .	5,631
Pencils. . . .	. . . .	186,363
Pens and penholders. . . .	. . . .	66,317
Perfumery and cosmetics. . . .	. . . .	390,502
Photographic materials. . . .	. . . .	758,320
Plaster, builders'. . . .	. . . .	50,427
Plaster of Paris. . . .	. . . .	21,459
Plated ware. . . .	. . . .	662,708
Platinum, and manufactures of, and scrap. . . .	. . . .	15,786
PROVISIONS, COMPRISING MEAT AND DAIRY PRODUCTS:		
Meat products—		
Beef products—		
Beef, canned. . . . lbs. . .	76,307,114	7,916,928
Beef, fresh. . . . lbs. . .	254,795,963	25,013,323
Beef, salted or pickled. . . . lbs. . .	52,801,220	3,814,671
Beef, other cured. . . . lbs. . .	1,126,032	102,184
Tallow. . . . lbs. . .	27,368,924	1,623,852
Hog products—		
Bacon. . . . lbs. . .	207,336,000	22,178,525
Hams. . . . lbs. . .	214,183,365	25,712,633
Pork, canned. . . . lbs. . .	13,590,897	1,369,687
Pork, fresh. . . . lbs. . .	20,966,113	2,035,491
Pork, salted or pickled. . . . lbs. . .	95,287,374	9,959,762
Lard. . . . lbs. . .	490,755,821	50,854,504

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
PROVISIONS, COMPRISING MEAT, ETC.—*Continued.*		
Lard compounds, and substitutes for (cottolene, lardine, etc.)....lbs...	46,130,004	Dollars. 3,607,542
Mutton....lbs...	6,144,020	532,476
Oleo and oleomargarine—		
Oleo, the oil....lbs...	126,010,339	11,981,888
Oleomargarine, imitation butter....lbs...	7,645,652	798,273
Poultry and game....	....	1,079,056
Sausage and sausage meats....lbs...	5,264,648	585,088
Sausage casings....	....	1,964,524
All other meat products—		
Canned....	....	1,831,940
All other....	....	2,101,785
Dairy products—		
Butter....lbs...	8,896,166	1,604,327
Cheese....lbs...	18,987,178	2,250,229
Milk....	....	921,026
Total....	....	179,839,714
Quicksilver....lbs...	1,415,464	762,201
Quills, crude and prepared....	....	3,976
Rags and paper stock....	....	89,710
Rice....lbs...	532,092	27,048
Rice bran, meal, and polish....lbs...	19,218,356	122,589
Rice root....	....	....
Roofing felt and paper....	....	104,280
Root beer....doz. qts...	949	834
Salt....lbs...	16,446,380	70,296
Sand....	....	73,956
SEEDS:		
Clover....lbs...	15,522,527	1,549,687
Cotton....lbs...	51,622,370	532,732
Flaxseed or linseed....bush...	4,128,130	5,698,492
Timothy....lbs...	18,289,917	853,829
Other grass seeds....	....	581,773
All other....	....	238,770
Total....	....	9,455,283
Shells....	....	94,766
Shoe findings....	....	57,406
SILK:		
Manufactures of....	....	412,415
Waste....lbs...	149,400	19,968
SOAP:		
Toilet or fancy....	....	573,588
All other....lbs...	46,590,354	1,879,189
Total....	....	2,452,777
Spermaceti and spermaceti wax....lbs...	197,966	44,915
Spices....	....	36,787
SPIRITS, WINES, AND MALT LIQUORS:		
Malt liquors—		
In bottles....doz. qts...	759,027	1,082,982
In other coverings....galls...	400,072	95,758
Total malt liquors....	....	1,178,740
Spirits, distilled—		
Alcohol—		
Wood....proof galls...	833,629	452,892
All other, including pure, neutral, or cologne spirits proof galls...	120,697	23,510
Brandy....proof galls...	18,117	19,213
Rum....proof galls...	1,096,719	1,458,393

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
SPIRITS, ETC.—*Continued.*		
Whisky—		Dollars.
Bourbon. . . . proof galls. . .	169,369	203,137
Rye. . . . proof galls. . .	104,236	223,480
All other. . . . proof galls. . .	48,014	62,358
Total spirits, distilled. . . .	2,390,808	2,442,983
Wine—		
In bottles. . . . doz. qts. . .	5,232	24,624
In other coverings. . . . galls. . .	678,150	290,552
Total wines. . . .	. . . .	315,176
Total spirits, wines, and malt liquors. . . .	. . . .	3,936,899
Sponges. . . . lbs. . .	95,159	50,306
Starch. . . . lbs. . .	27,759,599	832,943
Stereotype and electrotype plates. . . .	. . . .	37,419
Straw. . . .	. . . .	1,747
Straw and palm leaf, manufactures of	. . . .	480,569
SUGAR, MOLASSES, AND CONFECTIONERY:		
Molasses. . . . galls. . .	3,413,387	492,260
Sirup. . . . galls. . .	12,265,295	1,714,899
Sugar—		
Brown. . . . lbs. . .	99,101	3,545
Refined. . . . lbs. . .	10,421,055	358,537
Total. . . .	. . . .	2,569,241
Candy and confectionery. . . .	. . . .	535,412
Teasels. . . .	. . . .	34,258
Teeth, artificial. . . .	. . . .	4,715
Theatrical effects, etc. . . .	. . . .	41,656
TINS:		
Matte and scrap. . . .	. . . .	6,611
Manufactures of. . . .	. . . .	656,096
TOBACCO, AND MANUFACTURES OF:		
Unmanufactured—		
Leaf. . . . lbs. . .	357,496,342	34,972,033
Stems and trimmings. . . . lbs. . .	10,687,742	278,860
Total unmanufactured. . . .	368,184,084	35,250,893
Manufactures of—		
Cigars. . . . M. . .	1,966	46,962
Cigarettes. . . . M. . .	1,456,452	2,281,531
Plug. . . . lbs. . .	7,335,640	1,683,152
All other. . . .	. . . .	1,182,151
Total manufactures. . . .	. . . .	5,193,796
Toys. . . .	. . . .	281,591
Tripoli. . . .	. . . .	20,262
Trunks, valises, and traveling bags. . . .	. . . .	188,875
Varnish. . . . galls. . .	660,553	667,475
Vegetables:		
Beans and pease. . . . bush. . .	232,841	530,875
Onions. . . . bush. . .	145,509	116,624
Potatoes. . . . bush. . .	843,075	552,533
Vegetables, canned. . . .	. . . .	597,759
All other, including pickles and sauces. . . .	. . . .	745,697
Total. . . .	. . . .	2,543,488
VESSELS SOLD ABROAD:		
Steamers. . . . No. . .	123	196,164
Sailing vessels. . . . No. . .	. . . .	. . . .
Total. . . .	123	196,164

SUMMARY OF EXPORTS OF DOMESTIC MERCHANDISE—*Continued.*

Articles.	Quantities.	Values.
		Dollars.
Vinegar....galls...	103,417	18,072
Vulcanized fiber....	....	9,331
Wax, shoemakers'....	....	5,961
Whalebone....lbs...	113,204	507,552
White metal....	....	....
WOOD, AND MANUFACTURES OF:		
Timber and unmanufactured wood—		
Sawed....M feet....	530,659	7,462,111
Hewn....cubic feet...	3,291,498	787,082
Logs, and other....	....	4,506,728
Lumber—		
Boards, deals, and planks....M feet...	1,065,771	20,965,328
Joists and scantling....M feet...	46,894	647,920
Shingles....M...	38,211	86,245
Shooks—		
Box....	....	779,777
All other....No...	566,205	829,248
Staves....No...	55,879,010	4,740,680
Heading....	....	134,383
All other....	....	3,732,782
Total unmanufactured....	....	44,672,284
Manufactures of—		
Doors, sash, and blinds....	....	1,727,387
Furniture, not elsewhere specified....	....	4,454,309
Hogsheads and barrels, empty....	....	175,020
Trimmings, moldings, and other house finishings....	....	565,213
Wooden ware....	....	886,080
Wood pulp....lbs...	22,464,472	445,228
All other....	....	4,818,014
Total manufactures....	....	13,071,251
Total wood, and manufactures of....	....	57,743,535
WOOL, AND MANUFACTURES OF:		
Wool, raw....lbs...	518,919	71,818
Manufactures of—		
Carpets....yds...	69,337	57,979
Dress goods....yds...	7,719	6,442
Flannels and blankets....	....	48,141
Wearing apparel....	....	1,290,853
All other....	....	318,713
Total manufactures....	....	1,722,128
Yeast....	....	24,675
ZINC, AND MANUFACTURES OF:		
Unmanufactured—		
Dross....	....	674,262
Ore....tons...	48,731	1,386,694
Manufactures of—		
Pigs, bars, plates, and sheets....lbs...	3,539,071	186,192
All other....	....	99,481
Total manufactures....	....	285,673
All other articles....	....	150,315
Total value of exports of domestic merchandise....	....	1,392,231,302
Carried in cars and other land vehicles....	....	129,189,875
CARRIED IN AMERICAN VESSELS:		
Steam....	....	77,671,627
Sailing....	....	10,688,035
CARRIED IN FOREIGN VESSELS:		
Steam....	....	1,114,951,632
Sailing....	....	59,730,133

MERCHANDISE IMPORTED AND EXPORTED, AND THE ANNUAL EXCESS OF IMPORTS OR OF EXPORTS, 1860 TO 1903—SPECIE VALUES.

Year ending June 30	Exports.			Imports.	Total Exports and Imports.	Excess of Exports over Imports.	Excess of Imports over Exports.
	Domestic.	Foreign.	Total.				
	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
1860	316,242,423	17,333,634	333,576,057	353,616,119	687,192,176	....	20,040,662
1861	204,899,616	14,654,217	219,553,833	289,310,542	508,864,375	....	69,756,709
1862	179,644,024	11,026,477	190,670,501	189,356,677	380,027,178	1,313,824	....
1863	186,003,912	17,960,535	203,964,447	243,335,815	447,300,262	....	39,371,368
1864	143,504,027	15,333,961	158,837,988	316,447,283	475,285,271	....	157,609,295
1865	136,940,248	29,089,055	166,029,303	238,745,580	404,774,883	....	72,716,277
1866	337,518,102	11,341,420	348,859,522	434,812,066	783,671,588	....	85,952,544
1867	279,786,809	14,719,332	294,506,141	395,761,096	690,267,237	....	101,254,955
1868	269,389,900	12,562,999	281,952,899	357,436,440	639,389,339	....	75,483,541
1869	275,166,697	10,951,000	286,117,697	417,506,379	703,624,076	....	131,388,682
1870	376,616,473	16,155,295	392,771,768	435,958,408	828,730,176	....	43,186,640
1871	428,398,908	14,421,270	442,820,178	520,223,684	963,043,862	....	77,403,506
1872	428,487,131	15,690,455	444,177,586	626,595,077	1,070,772,663	....	182,417,491
1873	505,033,439	17,446,483	522,479,922	642,136,210	1,164,616,132	....	119,656,288
1874	569,433,421	16,849,619	586,283,040	567,406,342	1,153,689,382	18,876,698	....
1875	499,284,100	14,158,611	513,442,711	533,005,436	1,046,448,147	....	19,562,725
1876	525,582,247	14,802,424	540,384,671	460,741,190	1,001,125,861	79,643,481	....
1877	589,670,224	12,804,996	602,475,220	451,323,126	1,053,798,346	151,152,094	....
1878	680,709,268	14,156,498	694,865,766	437,051,532	1,131,917,298	257,814,234	....
1879	698,340,790	12,098,651	710,439,441	445,777,775	1,156,217,216	264,661,666	....
1880	823,946,353	11,692,305	835,638,658	667,954,746	1,503,593,404	167,683,912	....
1881	883,925,947	18,451,399	902,377,346	642,664,628	1,545,041,974	259,712,718	....
1882	733,239,732	17,302,525	750,542,257	724,639,574	1,475,181,831	25,902,683	....
1883	804,223,632	19,615,770	823,839,402	723,180,914	1,547,020,316	100,658,488	....
1884	724,964,852	15,548,757	740,513,609	667,697,693	1,408,211,302	72,815,916	....
1885	726,682,946	15,506,809	742,189,755	577,527,329	1,319,717,084	164,662,426	....
1886	665,964,529	13,560,301	679,524,830	635,436,136	1,314,960,966	44,088,694	....
1887	703,022,923	13,160,288	716,183,211	692,319,768	1,408,502,979	23,863,443	....
1888	683,862,104	12,092,403	695,954,507	723,957,114	1,419,911,621	....	28,002,607
1889	730,282,609	12,118,766	742,401,375	745,131,652	1,487,533,027	....	2,730,277
1890	845,293,828	12,534,856	857,828,684	789,310,409	1,647,139,093	68,518,275	....
1891	872,270,283	12,210,527	884,480,810	844,916,196	1,729,397,006	39,564,614	....
1892	1,015,732,011	14,546,137	1,030,278,148	827,402,462	1,857,680,610	202,875,686	....
1893	831,030,785	16,634,409	847,665,194	866,400,922	1,714,066,116	....	18,735,728
1894	869,204,937	22,935,635	892,140,572	654,994,622	1,547,135,194	237,145,950	....
1895	793,392,599	14,145,566	807,538,165	731,969,965	1,539,508,130	75,568,200	....
1896	863,200,487	19,406,451	882,606,938	779,724,674	1,662,331,612	102,882,264	....
1897	1,032,007,603	18,985,953	1,050,993,556	764,730,412	1,815,723,968	286,263,144	....
1898	1,210,291,913	21,190,417	1,231,482,330	616,049,654	1,847,531,984	615,432,676	....
1899	1,203,931,222	23,092,080	1,227,023,302	697,148,489	1,924,171,791	529,874,813	....
1900	1,370,763,571	23,719,511	1,394,483,082	849,941,184	2,244,424,266	544,541,898	....
1901	1,460,462,806	27,302,185	1,487,764,991	823,172,165	2,310,937,156	664,592,826	....
1902	1,355,481,861	26,237,540	1,381,719,401	903,320,948	2,285,040,349	478,398,453	....
1903	1,392,231,302	27,910,377	1,420,141,679	1,025,719,237	2,445,860,916	394,422,442	....

—Statistical Abstract of the United States.

UNITED STATES TRADE IN 1903.

INCREASED TRADE WITH CANADA—TRADE WITH GREAT BRITAIN AND THE EMPIRE.

By Hon. O. P. Austin, Chief of the United States Bureau of Statistics.

The commerce of the United States in the fiscal year ending June 30, 1903, has been the largest in the history of the country. This is true both of internal and foreign commerce. In the case of foreign commerce it is easily shown from the official figures of the imports and exports of the year. In the case of internal commerce, conclusions can be drawn from certain great facts of production, transportation, and importation for manufacturing purposes.

The total foreign commerce of the year amounted to practically 2 1-2 billions of dollars, and the internal commerce to fully twenty billions of dollars.

As already indicated, the measurement of the internal commerce of the country is not easy, but there are certain great factors of production, transportation, and the activity of the manufacturing industry, which make possible a fair statement of the internal commerce.

The Census states the value of the great products of the country, such as manufactures, agricultural products, the products of the forests, the fisheries, etc.; and by taking these great factors as a basis and calculating for but a single transaction in each of them, we get a grand total of 20 billions of dollars value, a sum practically equal to the international commerce of the world.

The last census showed the gross value of manufactures in 1900 to be 13 billions of dollars; the value of the agricultural products, nearly 4 billions; products of the mines, a billion dollars; and adding to these the products of the forests, fisheries and miscellaneous, and the cost of transportation to the consumer, it becomes apparent that a single transaction in each article would bring the total up to 20 billions of dollars. And all of the records of production and transportation for 1903 show that its activities were even greater than those of the census year. Every factory was busy; the railroads, even though equipped with additional carrying facilities, were working up to the limit of their capacity, and the reports of the Bureau of Statistics from the great lake-carrying trade showed a larger business than in any preceding year.

This record of the freight movement on the Great Lakes is an important index to the activities of the country, both in production and manufacturing. The section of the country fronting on Lake Superior is a great producer of wheat and of iron ore and copper. So the record of movements of freight through the canals connecting Superior with the lower lakes is an important indication of the demand of the great manufacturing section for iron and copper, and of the supply which that great region has of agricultural products for distribution to the world. The records of the Bureau of Statistics for the month of June and the portion of the navigation year ending with June shows a greater movement of freight through these canals than in any preceding year.

That the iron furnaces and works of the country were working up to their highest capacity is shown by the fact that despite the high prices which prevailed, the consumers of the country were compelled to turn to foreign countries to obtain a part of the iron and steel which they required; the imports of iron and steel being greater in 1903 than in many years.

The pig iron produced in the United States in the calendar year 1902 amounted to 17,821,307 gross tons. This makes the pig-iron production of the United States in 1902 larger than that of any two other countries of the world. The pig-iron production of 1902 is double that of 1896, and more than three times that of 1886.

Yet, despite this unparalleled production, the importations of iron and steel were greater in value in the fiscal year 1903 than in any year since 1891, and with that single exception, greater than in any year since 1883. The above facts regarding the production and importation of iron and steel are stated somewhat in detail because of the general belief that, in the United States at least, the consumption of iron and steel is a reliable index of the business activity of the country. If

this be true, it may be safely asserted that the business of the year 1903 has exceeded in value that of any of its predecessors.

LABOR.—Another indication of the general activity was the difficulty reported everywhere in obtaining labor. This was especially noticeable during the harvest season. The crop was abundant, and the demand for labor far in excess of the supply, so much so that reports from the West showed that in some cases farmers flagged railroad trains and after stopping them passed through the trains soliciting the passengers to step off and accept employment in the harvest field. Curiously these incidents were reported especially from the State of Kansas, which a few years ago was the scene of the greatest discontent because of the crop shortage, heavy farm indebtedness, and general conditions of financial depression. But the same general reports of difficulty of obtaining labor, especially in the agricultural districts, came from all parts of the country.

IMMIGRATION.—One effect of the prosperity and general demand for labor in the United States in the past few years is noticeable in the increased immigration. The number of immigrants entering the United States in 1903 was larger than in any preceding year. The total number of immigrants entering the United States in the fiscal year ending June 30, 1903, was 857,056. This was 25 per cent. in excess of any preceding year, practically twice as many as in 1900, and about four times as many as in 1898.

The attractions in the United States seem to have resulted in a marked increase in the immigration from the United Kingdom, though the largest increase is from the countries of southern Europe and Russia. The arrivals from England in the fiscal year 1903 were 26,219 against 13,571 in 1902; those from Scotland, 6,153 against 2,560 in 1902; and those from Ireland, 35,300 against 29,138 in 1902. From Germany the number was 40,086 against 28,304 in the preceding year. The largest increase, however, was from Italy, Austria-Hungary, and Russia. The number from Italy was 230 622, against 178,375 in the preceding year; from Austria-Hungary, 206,011 against 171,889 in the preceding year; and from Russia, 136,093 against 107.347 in 1902.

The reviews of the statistics of immigration which this unprecedented flood of arrivals has suggested show that the total number of immigrants arriving in the United States since 1800 is over 21 millions, and the number of persons of foreign birth now residing in the country, over 10 millions. Notwithstanding the demand for labor in the agricultural sections, however, the bulk of this large immigration remains in the cities. There is a great demand for labor in the manufacturing towns and cities, and they absorb a large proportion of the arrivals, while the mining regions also draw largely upon the new arrivals. This is especially true of the people from southern Europe and Russia, the chief additions to the agricultural population being those from Norway, Sweden, and Germany.

The foreign commerce of the year 1903, as already indicated, was the largest in the history of the country. This statement, however, relates to the commerce as a whole, combining imports and exports under that term. In imports the figures of the year were the largest in the history of the country, but in exports the figures were slightly below the high record of 1900. The total imports were $1,025,000,000, and the total exports $1,420,000,000. These figures, it will be observed, are stated in round millions, because they are more readily assimilated in this form.

This increase of imports and decrease of exports was doubtless due in both cases to the general prosperity and business activity already noted.

IMPORTS.—The increase in imports was chiefly in material for use in manufacturing, though there was a very considerable increase in importation of finished manufactures. This is quite natural in a time of business prosperity, when money is plentiful. The increase in importations of manufactures ready for consumption amounted to about 28 million dollars compared with the preceding year, and of diamonds and other precious stones, about 7 millions. In manufacturing material, however, the importations showed the greatest growth. In raw material for use in manufacturing the importations of the year were 48 million dollars in excess of the preceding year, and in partly manufactured material for use in manufacturing, the increase was 23 millions, making the total increase in manufacturing materials imported over 70 million dollars as compared with the preceding year.

The increase in partly manufactured

materials was chiefly in pig-iron, plates and bars of iron, etc. The increase in raw materials was chiefly in raw silk, fibres, tin, chemicals, india-rubber, and other articles of this character.

EXPORTS.—In exports the reduction was doubtless due to the unusual home demand both for foodstuffs and manufactures. Exports of iron and steel were 25 million dollars below those of 1900, and those of agricultural products were 70 millions below those of 1901. Yet the iron and steel manufacturing establishments of the country were turning out more of their products than ever before, and the agricultural production of 1903 was quite up to the usual total in most of the great staples.

U. S. COLONIAL TRADE.—One interesting development of the year 1903, and one which attracted some attention because of its novelty, was the announcement that the commerce between the United States and its noncontiguous territory amounted to 100 million dollars in 1903. This was the first time that the country had a clear view of the value of its commerce with the colonies, or noncontiguous territory, as they are generally designated.

Soon after the annexation of the Hawaiian Islands and Porto Rico, they were made customs districts of the United States, and as there was no law authorizing the collection of the statistics of commerce between the customs districts, the persons engaged in that commerce refused to furnish statements of the value of their shipments to and from the islands. As a result the country was without any information regarding the value or growth in this commerce.

The Bureau of Statistics, seeing the importance of some system by which this commerce could be measured, prepared a bill, which was passed by Congress, authorizing the collection of these statistics in the same manner as those of the commerce with foreign commerce. As a result, the country has now, for the first time since the annexation, a record of the commerce between the United States and all of its noncontiguous territory. This shows a grand total of 100 million dollars. Of this grand total of 100 millions, about 37 millions was merchandise shipped to the territory in question, 58 millions merchandise received from it, and nearly 5 millions gold bullion produced in Alaska territory. The territories included in this statement are Alaska, Porto Rico, the Hawaiian Islands, and the Philippines. It is a novel experience for the people of the United States, and they find it especially interesting to observe their own territory furnishing them a market for 37 million dollars' worth of merchandise, while their sales to the same territory in 1893 were less than 8 million dollars.

U. S. A. AND GREAT BRITAIN.—The development of the commerce of 1903, with reference to the United Kingdom and British territory in general, was of marked interest. The exports to the United Kingdom fell 24 million dollars, while the imports from that country increased 26 millions. This is especially interesting because of the fact that to practically all other European countries the exports increased. The total exports to all Europe were 1,039 million dollars against 1,008 millions in 1902, but those to the United Kingdom were 524 millions against 548 millions in 1902. To Germany there was an increase of 20 millions; to Russia an increase of 6 millions; to France 6 millions, and to Netherlands 3 millions.

The chief falling off in the exports to the United Kingdom was in cotton and wheat. The falling off in cotton amounted to 4 millions, and that of wheat 19 millions, though the latter was offset in part by an increase of 3 millions in flour.

Of the 26 millions increase in imports from the United Kingdom about 4 millions was in coal, chiefly due to the coal strike in the early part of the year, and the remainder, manufactures of various sorts, especially iron and steel, of which the total imports exceeded those of last year by 24 million dollars.

U. S. A. AND BRITISH COLONIES.—To practically all other parts of the British Empire the exports of the year showed an increase. Canada, despite the decrease in duty on products of Great Britain and the Colonies, made in 1897, 1898 and 1900, which was expected to place the United States at a great disadvantage, increased her takings of the products of the United States, 12 millions, the total exports to Canada in the fiscal year being 123 million dollars. The imports from Canada also increased, being 55 millions against 48 millions in 1903.

RESULTS OF CANADA'S TARIFF.—The first reduction in the Canadian tariff on products of the United Kingdom and most of the Colonies occurred

in April, 1897, a reduction of 12½ per cent. in the tariff on merchandise from the United Kingdom and her Colonies, while there was no reduction on merchandise from the United States. On June 30th, 1898, another reduction of 12½ per cent occurred, and in 1900 the reduction was made 33 1-3 per cent. Yet, comparing the imports for consumption in 1902 with those of 1896, as shown by the Canadian Statistical Year Book, the imports from the United Kingdom have increased 16 million dollars and those from the United States, 62 million dollars, while the figures of the United States for 1903 show a further increase of about 13 millions in exports to Canada.

CANADA'S TRADE WITH THE U. S. A. AND GREAT BRITAIN.—In 1882, according to the Canadian Statistical Year Book above quoted, the imports of Canada from Great Britain were 50 millions, and those from the United States 48 millions. In 1902, 20 years later, those from Great Britain were 49 millions, and those from the United States 120 millions, notwithstanding the fact that the tariff on products from Great Britain had been reduced one-third as against those from the United States.

Comparing 1902 with 1882, there is a slight reduction in the imports from the United Kingdom and an increase of about 150 per cent in those from the United States. Of the 123 million dollars' worth of exports from the United States to Canada in 1903, about 20 millions were manufactures of iron and steel; 6 millions coal; 8 millions wheat, flour and corn; 4 millions agricultural implements; 3 millions cotton manufactures; and the bulk of the remainder miscellaneous manufactures.

The convenience of buying from the salesman who brings the samples to the door of the purchaser and orders whatever is wanted by telephone across the border with the assurance that the goods will be delivered the next day, if desired, apparently more than balances the difference of 33 1-3 per cent in duty.

U. S. A. TRADE WITH THE BRITISH EMPIRE.—In general terms it may be said that the commerce between the United States and the British Empire in 1903 was over a billion dollars, of which 746 millions was exports and 325 millions imports. Of the 746 millions of exports to British territory 524 millions was to the United Kingdom; 123 millions to Canada; 33 millions to British Africa; 32 millions to Australasia and New Zealand; 10 millions to the British West Indies; and 8 millions to Hongkong. Of the 325 millions of imports from the British Empire, 191 millions was from the United Kingdom; 55 millions from Canada; 50 millions from India; 13 millions from the West Indies; and 7 millions from Hongkong.

ANALYSIS OF COMMERCE, 1893-1903.—The following tables present an analysis of the commerce of the United States from 1893 to 1903:

ANALYSIS OF THE TRADE OF THE U. S. A.

Imports into the United States.

(According to Continents.) [In millions of dollars.]

Year.	Europe.		N. America.		S. America.		Asia.		Oceania.		Africa.	
	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent
1893	458	52.91	183	21.21	102	11.80	87	10.11	25	3.00	9	.97
1894	295	45.05	166	25.49	100	15.29	66	10.10	21	3.28	3	.79
1895	383	52.41	133	18.29	112	15.32	77	10.61	17	2.39	5	.98
1896	418	53.69	126	16.27	108	13.96	89	11.49	24	3.16	11	1.43
1897	430	56.26	105	13.85	107	14.04	87	11.41	24	3.19	9	1.25
1898	305	40.66	91	14.83	92	14.95	92	15.03	26	4.36	7	1.17
1899	353	50.76	112	16.09	86	12.42	107	15.36	26	3.87	10	1.50
1900	440	51.84	130	15.30	93	11.02	139	16.45	34	4.07	11	1.32
1901	429	52.19	145	17.63	110	13.41	117	14.30	11	1.38	8	1.09
1902	475	52.61	151	16.73	119	13.26	129	14.35	14	1.57	13	1.48
1903	550	53.63	188	18.42	107	10.47	145	14.21	21	2.05	12	1.22

Exports from the U. S. A.
(According to Continents).

Year.	Europe.		N. America.		S. America.		Asia.		Oceania.		Africa.	
	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.
1893	661	78.10	119	14.13	32	3.85	16	1.91	11	1.32	5	.69
1894	700	78.57	119	13.42	33	3.72	20	2.34	11	1.34	4	.61
1895	627	77.76	108	13.45	33	4.15	17	2.15	13	1.62	6	.87
1896	673	76.26	116	13.21	36	4.11	25	2.90	17	1.95	13	1.57
1897	813	77.39	124	11.89	33	3.21	39	3.74	22	2.16	16	1.61
1898	973	79.07	139	11.35	33	2.75	44	3.63	22	1.78	17	1.42
1899	936	76.33	157	12.87	35	2.91	48	3.94	29	2.43	18	1.52
1900	1,040	74.60	187	13.45	38	2.79	64	4.66	43	3.11	19	1.79
1901	1,136	76.39	196	13.21	44	2.98	49	3.34	35	2.36	25	1.72
1902	1,008	72.96	203	14.75	38	2.76	63	4.63	34	2.48	33	2.44
1903	1,029	72.49	215	15.18	41	2.89	57	4.09	37	2.64	38	2.71

Exports of Domestic Merchandise from the U. S. A., 1893 to 1903.
(According to classes.)

Year ending June 30.	Manufactures.		Agricultural Products.		Products of the Mines.		Products of the Forests.		Products of the Fisheries.		Miscellaneous Products.		Total.
	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.
1893	158	19.02	615	74.05	20	2.41	28	3.38	5	.67	3	.47	831
1894	183	21.14	628	72.28	20	2.35	28	3.22	4	.49	4	.52	869
1895	183	23.14	553	69.73	18	2.33	28	3.61	5	.67	4	.52	793
1896	228	26.48	569	66.02	20	2.32	33	3.91	6	.79	4	.48	863
1897	277	26.87	683	66.23	20	2.01	40	3.92	6	.63	3	.34	1,032
1898	290	24.02	853	70.54	19	1.60	37	3.13	5	.45	3	.26	1,210
1899	339	28.21	784	65.19	28	2.34	42	3.49	5	.50	3	.27	1,203
1900	433	31.65	835	60.98	37	2.76	52	3.81	6	.46	4	.34	1,370
1901	412	28.22	943	64.62	37	2.60	54	3.72	7	.53	4	.31	1,460
1902	403	29.77	851	62.83	39	2.90	48	3.55	7	.57	5	.38	1,355
1903	408	29.32	873	62.72	38	2.79	57	4.15	7	.56	6	.46	1,392

Imports into the U. S. A., 1893 to 1903.
(According to classes.)

Year ending June 30	Food and Live Animals.		Crude Articles for Domestic Industries.		Articles Wholly or Partially Manufactured for Use as Materials in Mechanic Arts.		Articles Manufactured Ready for Consumption.		Luxuries, and other Articles of Voluntary Use.		Total.
	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.	Per Cent.	Mills. Dolls.
1893	269	31.89	218	25.85	94	11.20	153	18.22	108	12.84	844
1894	275	43.33	126	19.89	65	10.32	99	15.60	69	10.86	636
1895	226	30.97	187	25.64	83	11.46	140	19.25	92	12.68	731
1896	228	30.13	201	26.57	79	10.46	160	21.09	89	11.75	759
1897	254	32.27	207	26.26	69	8.85	165	20.91	92	11.72	789
1898	170	29.08	188	32.16	58	9.91	94	16.15	74	12.70	587
1899	207	30.27	218	31.82	60	8.76	110	16.15	89	13.00	685
1900	216	26.02	299	36.04	80	9.70	130	15.72	103	12.51	830
1901	213	26.45	270	33.54	74	9.27	135	16.81	112	13.93	807
1902	201	22.26	327	36.27	91	10.09	150	16.66	132	14.72	903
1903	218	21.18	375	36.58	114	11.15	170	16.61	147	14.38	1,025

—Daily Mail Year Book.

IMPORTS OF MERCHANDISE, BY PRINCIPAL ARTICLES AND CLASSES, IN ORDER OF MAGNITUDE IN 1903.

Articles.	1903.	Articles.	1903.
	Dollars.		Dollars.
Sugar	72,088,973	Articles, the growth, etc., of the United States, returned	7,170,573
Chemicals, drugs, and dyes	64,351,199	Metals, and manufactures of	7,057,202
Coffee	59,200,749	Spices	4,815,125
Hides and skins	58,031,613	Paper, and manufactures of	4,733,036
Cotton, manufactures of	52,462,755	Provisions: Meat and dairy products	4,703,536
Iron and steel, and manufactures of	51,617,312	Vegetables	4,581,355
Silk, unmanufactured	50,011,050	Animals	4,533,845
Fibres, vegetable, etc., manufactures of	39,334,521	Books, maps, engravings, etc	4,323,938
Silk, manufactures of	35,963,552	Art works	4,310,315
Fibres, vegetable, etc., unmanufactured	34,462,513	Toys	4,232,074
Diamonds, and other precious stones	31,479,223	Lead, in ore	4,073,099
India rubber and gutta-percha, crude	31,004,541	Hats, bonnets, and hoods, and materials for	3,871,278
Wood, manufactures of	28,746,271	Matting, for floors, etc	3,780,050
Fruits and nuts	23,726,636	Cement	3,607,666
Tin, in bars, blocks, or pigs	23,618,802	Copper ore	3,385,524
Wool, unmanufactured	22,152,961	Fertilizers	3,100,276
Tobacco, and manufactures of	20,579,120	Rice	3,061,473
Wool, manufactures of	19,546,385	Breadstuffs	3,023,160
Copper, and manufactures of	17,505,247	Paper stock, crude	3,015,084
Spirits, malt liquors, and wines	17,171,617	Household and personal effects	2,856,007
Tea	15,659,229	Seeds	2,831,279
Furs, and manufactures of	15,301,912	Hair, and manufactures of	2,775,084
Oils	12,283,957	Clocks and watches, and parts of	2,672,310
Leather, and manufactures of	11,294,167	Bristles	2,654,604
Cotton, unmanufactured	10,892,591	Cork wood, or cork bark, and manufactures of	2,567,580
Coal, bituminous	10,562,185	Feathers and downs, crude, not dressed, etc	2,476,659
Earthen, stone, and china ware	10,512,052	Iron ore	2,351,278
Fish	8,635,583	Hay	2,238,109
Cocoa, crude, and leaves and shells of	7,820,087	Jewelry, and manufactures of gold and silver	2,007,433
Glass and glassware	7,255,879	All other articles	55,637,603
		Total	1,025,719,237

—Foreign Commerce and Navigation, Bureau of Statistics.

MOTIVE-POWER APPLIANCES.

By Edward H. Sanborn, Expert Special Agent Twelfth Census.

The 1,170 establishments covered by the report produced during the census year 40,533 steam boilers, representing an aggregate of 2,928,983 horsepower, with a total value of $25,663,445. Of steam engines of all types there were manufactured 29,120, representing 2,210,727 horsepower, and valued at $28,019,971. The number of internal-combustion engines, using gas, petroleum, or other vapors, produced by these establishments was 18,531, their aggregate horsepower was 164,662, and their total value amounted to $5,579,398. There were also manufactured 2,680 water motors, including overshot and undershot wheels, turbines, and impact wheels, with an estimated total of 367,934 horsepower, and an aggregate value of $1,520,849. The totals for all primary powers, exclusive of steam boilers, were as follows: Number of units, 50,331; aggregate horsepower, 2,743,323; total value, $35,120,218. The other products of these 1,170 establishments amounted in value to $84,754,239; the amounts received for custom work and repairing reached a total of $26,664,243, and the total output of all products and all classes of work represented a value of $172,202,145.

The table shows the number, aggregate horsepower, and total value of each kind of motive-power appliances produced by these establishments during the census year.

NUMBER, AGGREGATE HORSEPOWER, AND VALUE OF PRIMARY POWERS: 1900.

Number of establishments	1,170
Steam boilers:	
Fire tube—	
Number	35,802
Aggregate horsepower	1,943,222
Total value	$18,037,451
Water tube—	
Number	4,731
Aggregate horsepower	985,761
Total value	$7,625,994
Steam engines:	
Marine—	
Number	767
Aggregate horsepower	396,047
Total value	$7,018,369
Fixed cut-off throttling—	
Number	21,806
Aggregate horsepower	658,111
Total value	$7,963,805
High speed variable automatic cut-off—	
Number	3,823
Aggregate horsepower	314,668
Total value	$3,282,787
Low speed variable automatic cut-off—	
Number	2,724
Aggregate horsepower	841,901
Total value	$9,755,010
Internal-combustion engines:	
Number	18,531
Aggregate horsepower	164,662
Total value	$5,579,398
Overshot or undershot water wheels:	
Number	58
Aggregate horsepower	1,257
Total value	$12,250
Turbine water wheels:	
Number	1,665
Aggregate horsepower	311,527
Total value	$1,232,090
Impact water wheels:	
Number	957
Aggregate horsepower	55,150
Total value	$276,509
Primary powers, all kinds:	
Number	50,331
Aggregate horsepower	2,743,323
Total value	$35,120,218

POWER, COMPARATIVE SUMMARY: 1870 TO 1900.

[Twelfth Census, Vol. VII, pages cccxvi, and 582.]

Power.	Date of Census.				Per Cent. of Increase.		
	1900.	1890.	1880.	1870.	1890 to 1900.	1880 to 1890.	1870 to 1880.
Total number of establishments	512,191	355,405	253,852	252,148	44.1	40.0	0.7
Total number of establishments reporting power	169,364	100,726	85,923	(1)	68.1	17.2	......
Per cent of establishments reporting power to total number	33.1	28.3	33.8	....	......	......	......
Total horsepower	11,298,119	5,954,204	3,410,837	2,346,142	89.8	74.6	45.4
Average horsepower per establishment	66.7	59.1	39.7	[2]9.3	12.9	48.9	[3]26.9
Steam engines:							
Number	156,051	91,403	56,483	(1)	70.7	61.8	......
Horsepower	8,741,338	4,581,305	2,185,458	1,215,711	90.8	109.6	79.8
Per cent of total horsepower	77.4	76.9	64.1	51.8	......	......	......
Gas engines:							
Number	14,884	(1)	(1)	(1)	......	......	......
Horsepower	143,850	8,930	(1)	(1)	1,510.9	......	......
Per cent of total horsepower	1.3	0.1	....	....	......	......	......
Water wheels:							
Number	39,168	39,005	55,404	(1)	0.4	[3]29.6	......
Horsepower	1,726,661	1,255,045	1,225,379	1,130,431	37.6	2.4	8.4
Per cent of total horsepower	15.3	21.1	35.9	48.2	......	......	......
Electric motors:							
Number	16,912	(1)	(1)	(1)	......	......	......
Horsepower	310,729	15,569	(1)	(1)	1,895.8	......	......
Per cent of total horsepower	2.8	0.3	....	....	......	......	......
Other power:							
Number	2,144	(1)	(1)	(1)	......	......	......
Horsepower	54,490	4,784	(1)	(1)	1,039.0	......	......
Per cent of total horsepower	0.5	0.1	....	....	......	......	......
Total rented horsepower	321,051	88,571	(1)	(1)	262.5	......	......
Per cent of total horsepower	2.8	1.5	....	....	......	......	......
Electric rented horsepower	183,682	(4)	(1)	(1)	......	......	......
All other rented horsepower	137,369	(4)	(1)	(1)	......	......	......

[1] Not reported. [2] Average for all establishments. [3] Decrease. [4] Not reported separately

METAL-WORKING MACHINERY IN THE UNITED STATES—KIND, QUANTITY, AND VALUE OF PRODUCTS: 1900.

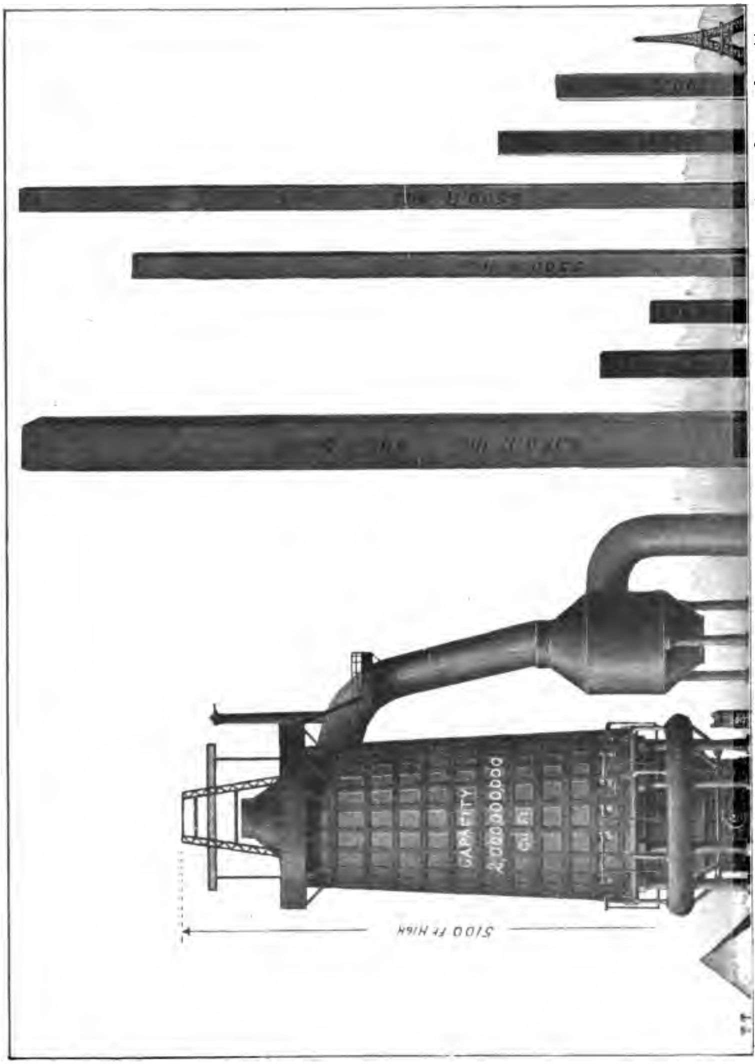
Number of establishments reporting	397
Hammers—steam, power, and drop:	
Number	857
Value	$671,287
Forging machines, including bolt headers, and all other machines for forging hot metal with dies and by pressure:	
Number	821
Value	$424,774
Stamping, flanging, and forming machines for plate and sheet metal:	
Number	7,895
Value	$1,180,960
Punching and shearing machines:	
Number	5,269
Value	$1,219,605
Bending and straightening rolls:	
Number	914
Value	$202,230
Riveting machines:	
Number	202
Value	$139,295
Lathes:	
Hand—	
Number	3,945
Value	$306,081
Engine—	
Number	12,089
Value	$4,451,867
Turret, including all automatic or semi-automatic lathes for making duplicate pieces—	
Number	3,687
Value	$2,449,121
Boring and turning mills or vertical lathes:	
Number	534
Value	$1,123,314
Boring and drilling machinery, including all machines using drills or boring bars:	
Number	22,890
Value	$2,779,983
Planers, including plate-edge planers:	
Number	1,543
Value	$1,808,955
Slotters and shapers:	
Number	3,076
Value	$1,136,350
Milling machines, including all machines using a milling cutter:	
Number	4,119
Value	$2,171,966
Sawing machines:	
Number	2,846
Value	$222,563
Grinding and polishing machinery, including all machines using abrasive cutters:	
Number	10,014
Value	$880,965
Bolt, nut, and pipe threading and tapping machines:	
Number	2,088
Value	$698,362
Pneumatic hand tools:	
Number	6,751
Value	$143,325
All other metal working machines, value	$2,726,901
All other products, value	$16,375,956
Amount received for custom work and repairing	$3,271,369
Total value of all products	$44,385,229

—U. S. Census Bulletin.

OUR IRON AND STEEL PRODUCTION.

The statement that in 1902 forty per cent. of the pig iron in the world was produced in the United States gives one no very definite realization of the quantity of that product, though he be reminded on every hand by iron and steel ships, bridges, railroads, buildings, machinery, tools, nails, tacks, etc., *ad nauseam*, that this is the iron age. Even the statement that the United States last year mined over thirty million long tons of iron ore gives one no adequate impression of the vastness of this amount. On the other hand, if one should see the entire iron ore production of the year piled up in a single heap, he would readily comprehend this quantity by a comparison of the pile with familiar objects in the landscape. This shows us that it is large numbers instead of large quantities which confuse the mind; for example, the statement that a wagon holds over 30,000,000 grains of coal would give a person a very hazy idea of the actual quantity specified, but he would immediately comprehend the quantity if told that it represented two tons; for a larger unit of weight would be used, thereby reducing the count to a figure well within the mental grasp. Thus in trying to represent to our readers just how large are the quantities of materials used in the iron and steel industry, we have endeavored to choose larger units of measurement; and finding that our standard measures are far too small for the purpose, we have resorted to the use of familiar landmarks as bases of comparison.

As a unit of bulk, no larger single



1—Great Pyramid. 2—Blast Furnace. 3—Park Row Building. 4—Coke. 5—Coal. 6—Charcoal. 7—Limestone. 8—Iron Ore. 9—Pig Iron. 10—Steel. 11—Eiffel Tower.

COMPARATIVE DIAGRAM SHOWING THE TOTAL ANNUAL AMOUNT OF RAW MATERIALS OF THE IRON AND STEEL INDUSTRY IN THE UNITED STATES, AS COMPARED WITH THE FINISHED PRODUCTS SHOWN ON PAGES 296, 297 AND 298.

monument has man produced than the old pyramid of Cheops, and large though it be, it is all too small when used as a unit by which to measure the stupendous volume of material used in our pig-iron production of a single year. In the accompanying illustration, the huge blast furnace shown at the left represents a furnace which would receive at a single charge all our iron ore production during the year 1902, together with the fuel and limestone used. The charge measures approximately two billion cubic feet, or to use our proposed unit of bulk, this would be equivalent to twenty-four pyramids. As many individuals may have formed no adequate conception of the size of the Great Pyramid, we have used as an additional basis of comparison the tallest building in the world, namely, the Park Row Building in New York. This building measures 390 feet in height, and it would require thirteen such buildings placed one above the other, to equal the height of our hypothetical blast furnace.

PROPORTION OF FINISHED PRODUCTS FORMED INTO RAIL.

FUEL.

Of the contents of the blast furnace by far the larger bulk is fuel, though the weight of the iron ore is almost twice that of the fuel. The square columns in our illustration will serve to give one some idea of the amount of fuel which was consumed in 1902 by the blast furnaces of the United States. A fair estimate would be about 16,000,000 tons of coke, 1,600,000 tons of coal, and 300,000 tons of charcoal. Coke is so light that if the 16,000,000 tons were built up in a column 400 feet square, the column would reach an altitude of 6,500 feet. No human monument is large enough to give us, by comparison with this column, any idea of such a height. If the base of the column were situated at sea level, a person at the top could look down on the summit of Mount Washington, N. H., and it would overtop every mountain in this country east of the Rockies.

Our column of coal includes both anthracite and bituminous. In the last two years there has been a considerable falling off in the use of anthracite, while bituminous coal mixed with coke has shown a great increase over former years, so that our column would probably be made up of two parts bituminous to one part anthracite coal. Their combined bulk would form a column 200 feet square by 1,300 feet high—a midget in comparison to the coke column, but not so small after all when compared with the Park Row Building.

Charcoal, which is the smallest item in the fuel statistics for 1902, or about one-fifth of the number of tons of coal, yet forms a column nearly two-thirds the height of the coal column, or twice that of the Park Row Building.

FLUX.

The amount of limestone used for fluxing purposes last year amounted to 9,490,090 tons. This would make a column 5,500 feet high, with a cross-section 200 feet square. It may be interesting to note here that oyster shells are used in one of the furnaces in Maryland in place of limestone.

IRON ORE.

The next column, which is of a height equal to that of the coke column, is composed of 34,636,121 tons of iron ore. However, this represents in bulk only one-quarter that of the coke.

PIG IRON.

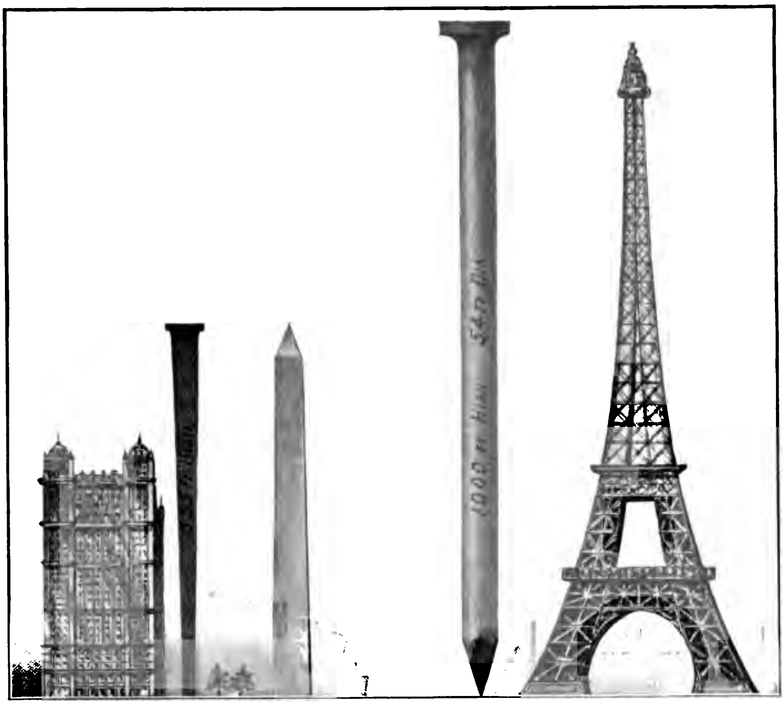
All the above-mentioned materials were used last year to produce 17,821,307 tons of pig iron. This makes a column twice the height of the Eiffel Tower, the tallest monument to human skill in the world.

STEEL.

The larger part of the pig iron production of this country is converted into steel; 14,947,250 tons represent the total output for last year. Of this, 9,138,363 tons were made by the Bessemer process, 5,687,729 by the open-hearth process, and 121,158 tons were crucible steel.

FINISHED PRODUCTS.

Of the finished products for the year, 2,947,933 tons represent the amount of iron and steel formed into rails. If all this metal were rolled into a single rail of standard proportions, it would measure approximately 81 feet high, and would be about a mile and one-fifth long. The base would, of course, equal the height, and the tread would have a width of 43 feet. In our



Park Row Building. Cut Nail. Washington Monument. Wire Nail. Eiffel Tower.

PROPORTION OF FINISHED PRODUCTS FORMED INTO WIRE NAILS AND CUT NAILS.

illustration we have shown the relative proportions of a locomotive of average size placed on this rail.

Next in quantity to the iron and steel rail production is last year's output of plates and sheets; 2,665,409 tons of metal were thus converted. This amount, if rolled into a single sheet of No. 30 standard gage, which is the thinnest sheet steel commercially used, would cover 420 square miles, or nearly twenty times the area of the island of Manhattan. The extent of this area is illustrated in the accompanying sketch plan of New York city and its vicinity.

PROPORTION OF FINISHED PRODUCTS FORMED INTO PLATES AND SHEETS.

The production of nails forms no small part of the finished products for the year. Wire nails represent, of course, a much larger part of the output. The totals are 10,982,246 100-pound kegs of wire nails and 1,633,762 100-pound kegs of cut nails. Following the method in our two previous comparisons, we have represented each amount by a single nail of standard proportions. The cut nail would tower far above the Park Row Building, measuring almost exactly the height of the Washington Monument, while the wire nail would rise to nearly double this height, overtopping the Eiffel Tower, and forming a solid column of metal 54 feet in diameter and 1,000 feet high.

CARRIAGES AND WAGONS.

The manufacture of carriages and wagons has been carried on in the United States practically since the time of the early settlers. In the Census year 1900 there were 7,632 establishments, having a capital of $118,187,838. The industry gave employment to 66,842 persons (officials, clerks, wage-earners) and the salaries and wages were $33,888,843. The cost of materials used was $56,676,073. The value of products, including custom work and repairing, was $121,537,276. The increase in product of the Census year 1900 over Census year 1890 was $18,856,835.

The trend of the industry is toward the Central States, where land is cheaper, where suitable lumber is abundant and prices are therefore favorable, and where also the developed railroad systems afford abundant means of transportation. The same rapid development of the industry is seen in certain of the Southern States, such as North Carolina, Tennessee and Virginia, where lumber is cheap and where manufactures are fast gaining industrial predominance. The increase in Massachusetts, New Jersey, New York and Pennsylvania is due partly to the growing use of the automobile, to the diminishing use of the bicycle, and materially to the more perfect segregation of the "factory product" and that formerly classed as "custom work and repairing."

PHONOGRAPHS AND TALKING MACHINES.

In 1900 there were eleven establishments engaged in the manufacture of phonographs and other talking machines. The capital invested was $3,348,282, and the industry gave employment to 1,267 wage-earners and 144 salaried officials and clerks. The value of the product was $2,246,274. The number of completed machines was 151,403, the number of horns, 28,423, and the number of records produced was 2,763,277.

VALUE OF EXPORTS OF AGRICULTURAL IMPLEMENTS, 1896 TO 1900, INCLUSIVE.

Countries and Classes.	1896.	1897.	1898.	1899.	1900.
Aggregate	$5,176,775	$5,240,686	$7,609,732	$12,432,197	$16,099,149
Mowers, reapers, and parts of same:					
Total	3,212,423	3,127,415	5,500,665	9,053,830	11,243,763
France	360,577	494,469	1,146,551	1,678,865	2,652,795
Germany	480,773	538,430	1,100,210	1,503,968	2,529,422
Russia	387,316	265,442	409,368	863,476	710,066
United Kingdom	333,791	360,079	874,296	1,040,059	982,188
Canada	132,945	248,359	440,878	934,962	1,192,458
Argentina	570,332	228,391	182,283	1,074,749	1,194,961
British Australasia	195,533	302,586	421,975	358,862	466,397
All other countries	751,156	689,659	925,104	1,598,889	1,515,476
Plows, cultivators, and parts of same:					
Total	746,604	590,779	927,250	1,545,410	2,178,098
France	15,048	7,992	49,330	59,105	68,197
Germany	6,402	11,206	15,450	38,898	227,378
Russia	23,777	3,129	29,566	14,902	45,993
United Kingdom	43,105	36,142	74,763	69,737	179,950
Canada	40,533	73,023	182,809	207,480	247,306
Argentina	161,347	104,072	151,737	440,996	388,903
British Australasia	32,450	39,527	108,116	166,035	162,109
All other countries	423,942	315,688	315,479	548,257	858,262
All other implements, and parts of same:					
Total	1,217 748	1,522,492	1,181,817	1,832,957	2,677,288
France	91,359	121,495	56,286	43,689	189,583
Germany	94,552	161,182	116,582	103,845	129,654
Russia	65,236	253,495	19,653	59,848	271,671
United Kingdom	211,654	246,096	195,966	262,597	188,305
Canada	186,166	143,455	157,728	378,612	571,442
Argentina	122,488	82,849	43,034	163,274	221,880
British Australasia	57,739	148,872	167,474	243,775	269,776
All other countries	388,554	365,048	425,094	577,317	834,977

—United States Treasury Department: Report on Commerce and Navigation, 1900.

VALUE OF IMPLEMENTS ON FARMS, BY STATES AND TERRITORIES, 1900.

States and Territories.	Value of Implements on Farms.	States and Territories.	Value of Implements on Farms.
United States	$749,776,660	Missouri	$28,602,680
		Montana	3,671,900
Alabama	$8,675,900	Nebraska	24,940,450
Alaska	690	Nevada	888,560
Arizona	765,200	New Hampshire	5,163,090
Arkansas	8,750,060	New Jersey	9,330,030
California	21,311,670	New Mexico	1,151,610
Colorado	4,746,755	New York	56,006,000
Connecticut	4,948,300	North Carolina	9,072,600
Delaware	2,150,560	North Dakota	14,055,560
District of Columbia	136,060	Ohio	36,354,150
Florida	1,963,210	Oklahoma	6,573,015
Georgia	9,804,010	Oregon	6,506,725
Idaho	3,295,045	Pennsylvania	50,917,240
Illinois	44,977,310	Rhode Island	1,270,270
Indiana	27,330,370	South Carolina	6,629,770
Indian Territory	3,939,480	South Dakota	12,218,680
Iowa	57,960,660	Tennessee	15,232,670
Kansas	29,490,580	Texas	30,125,705
Kentucky	15,301,860	Utah	2,922,550
Louisiana	28,536,700	Vermont	7,538,490
Maine	8,802,720	Virginia	9,911,040
Maryland	8,611,220	Washington	6,271,630
Massachusetts	8,828,950	West Virginia	5,040,420
Michigan	28,795,380	Wisconsin	29,237,010
Minnesota	30,099,230	Wyoming	1,366,000
Mississippi	9,556,805		

SUMMARY OF PROGRESS OF THE UNITED STATES

Compiled from "Territorial and Commercial Expansion of the United States,"

Area, Population, and Industries.	In	1800.	1850.
Area and Population:			
Area[1]	Sq. miles	827,844	2,980,959
Population [2]	Number	5,308,483	23,191,876
Per square mile [2]	Number	6.41	7.78
Wealth:			
Total [3]	Dollars	...	7,135,780,000
Per capita	Dollars	...	307.69
Public-debt Statement:			
Public debt, less cash in the Treasury [5]	Dollars	82,976,294.35	63,452,773.55
Per capita, less cash in Treasury	Dollars	15.63	2.74
Interest-bearing debt [6]	Dollars	82,976,294	63,452,774
Annual interest charge	Dollars	3,402,601	3,782,393
Per capita	Dollars	0.64	0.16
Coinage:			
Gold coined	Dollars	317,760	31,981,739
Silver coined	Dollars	224,296	1,866,100
Commercial ratio of silver to gold	Dollars	15.68	15.70
Money in Circulation:			
Gold in circulation [7] / Silver in circulation [7]	Dollars	[8] 16,000,000	[8] 147,395,456
Gold certificates in circulation	Dollars	...	...
Silver certificates in circulation	Dollars	...	...
United States notes (greenbacks) in circulation	Dollars	...	...
National-bank notes in circulation (October 31)	Dollars	...	...
Miscellaneous currency in circulation [9]	Dollars	10,500,000	131,366,526
Total money in circulation	Dollars	26,500,000	278,761,982
Per capita	Dollars	5.00	12.02
National Banks:			
Reporting nearest June 30	Number	...	...
Capital	Dollars	...	...
Loans and discounts	Dollars	...	...
Bank Clearings:			
New York	Dollars	...	...
Total United States	Dollars	...	...
Bank Deposits:			
National banks (individual)	Dollars	...	...
Savings banks	Dollars	...	43,431,130
State banks	Dollars	...	109,586,595
Loan and trust companies	Dollars	...	...
Private banks [10]	Dollars	...	...
Total bank deposits	Dollars	...	...
Depositors in savings banks	Number	...	251,354
Government Receipts:			
Net ordinary [11]	Dollars	10,848,749	43,592,889
Customs	Dollars	9,080,933	39,668,686
Internal revenue	Dollars	809,397	...
Government Expenditures:			
Net ordinary [12]	Dollars	7,411,370	37,165,990
War	Dollars	2,560,879	9,687,025
Navy	Dollars	3,448,716	7,904,725
Pensions	Dollars	64,131	1,866,886

[1] Exclusive of Alaska and islands belonging to the United States.
[2] No official figures in other than census years.
[3] True valuation of real and personal property.
[4] Estimated.
[5] 1800 to 1840, outstanding principal of the public debt January 1; 1850 to 1855, outstanding principal of the public debt July 1.
[6] Figures for the years 1800 to 1855 include the total public debt.
[7] Gold and silver cannot be stated separately prior to 1876. From 1862 to 1875, inclusive, gold and silver were not in circulation except on the Pacific coast, where it is estimated that the average specie circulation was about $25,000,000, and this estimate is continued for the three following years under the head of gold. After that period gold was available for circulation.

IN ITS AREA, POPULATION, AND MATERIAL INDUSTRIES.

Issued by the Bureau of Statistics, Department of Commerce and Labor.

1860.	1870.	1880.	1890.	1900.	1903.
3,025,600	3,025,600	3,025,600	3,025,600	3,025,600	3,025,600
31,443,321	38,558,371	50,155,783	62,622,250	76,303,387	80,372,000
10.39	12.74	16.57	20.70	25.22	26.56
16,159,616,000	30,068,518,000	42,642,000,000	65,037,091,000	[4] 94,300,000,000	....
513.93	779.83	850.20	1,038.57	1,235.86	....
59,964,402.01	2,331,169,956.21	1,919,326,747.75	890,784,370.53	1,107,711,257.89	925,011,637.31
1.91	60.46	38.27	14.22	14.52	11.51
64,640,838	2,046,455,722	1,723,993,100	725,313,110	1,023,478,860	914,541,410
3,443,687	118,784,960	79,633,981	29,417,603	33,545,130	25,541,573
0.11	3.08	1.59	0.47	0.44	0.32
23,473,654	23,198,788	62,308,279	20,467,183	99,272,943	43,683,971
2,259,390	1,378,256	27,411,694	39,202,908	36,345,321	19,874,440
15.29	15.57	18.05	19.75	33.33	38.10
[8] 228,304,775	25,000,000	225,695,779	374,258,923	610,806,472	617,260,739
		68,622,345	110,311,336	142,050,334	165,117,934
....	....	7,963,900	130,830,859	200,733,019	377,258,559
....	....	5,789,569	297,556,238	408,465,574	454,733,013
....	324,962,638	327,895,457	334,688,977	313,971,545	334,248,567
....	288,648,081	337,415,178	181,604,937	300,115,112	399,996,709
207,102,477	36,602,075	....	....	79,008,942	19,076,648
435,407,252	675,212,794	973,382,228	1,429,251,270	2,055,150,998	2,367,692,169
13.85	17.50	19.41	22.82	26.94	29.42
....	1,612	2,076	3,484	3,732	4,939
....	427,235,701	455,909,565	642,073,676	621,536,461	743,506,048
....	719,341,186	994,712,646	1,933,509,333	2,623,512,201	3,415,045,751
7,231,143,057	27,804,539,406	37,182,128,621	37,660,686,572	51,964,588,564	70,833,655,940
....	....	....	58,845,279,505	84,582,450,081	114,068,837,569
....	542,261,563	833,701,034	1,521,745,665	2,458,092,758	3,200,993,509
149,277,504	549,874,358	819,106,973	1,524,844,506	2,449,547,885	2,935,204,845
257,229,562	....	208,751,611	553,054,584	1,266,735,282	1,814,570,163
....	....	90,008,008	336,456,592	1,028,232,407	1,589,398,796
....	....	182,667,235	99,521,667	96,206,049	133,217,990
....	....	2,134,234,861	4,035,622,914	7,298,814,381	9,673,385,303
693,870	1,630,846	2,335,582	4,258,893	6,107,083	7,305,228
56,054,600	395,959,834	333,526,501	403,080,983	567,240,852	560,396,674
53,187,512	194,538,374	186,522,065	229,668,585	233,164,871	284,479,582
....	184,899,756	124,009,374	142,606,706	295,327,927	230,810,124
60,056,755	164,421,507	119,090,062	261,637,203	447,553,458	477,542,658
16,472,203	57,655,675	38,116,916	44,582,838	134,774,768	118,619,520
11,514,650	21,780,230	13,536,985	22,006,206	55,953,078	82,618,034
1,100,802	28,340,202	56,777,174	106,936,855	140,877,316	138,425,646

[8] Total specie in circulation; gold and silver were not separately stated prior to 1876.

[9] Includes notes of bank of United States, State bank notes, demand notes of 1862 and 1863; fractional currency 1863 to 1878; Treasury notes of 1890, 1891 to date, and currency certificates, act of June 8, 1872, 1892 to 1900.

[10] Includes all private banks from 1875 to 1882; from 1887 to date includes only those voluntarily reporting, estimated at one-fourth of total private banks.

[11] "Net ordinary receipts" include receipts from customs, internal revenue, direct tax, public lands, and "miscellaneous," but do not include receipts from loans, premiums, or Treasury notes, or revenues of Post-office Department.

[12] "Net ordinary expenses" include expenditures for war, Navy, Indians, pensions, and "miscellaneous," but do not include payments for interest, premiums, or principal of public debt, or expenditures for postal service.

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

Area, Population, and Industries.	In	1800.	1850.
Government Expenditures—Continued.			
Interest on public debt	Dollars	3,402,601	3,782,393
Pensioners	Number	....	....
IMPORTS OF MERCHANDISE:			
Total	Dollars	91,252,768	173,509,526
Per capita [1]	Dollars	17.19	7.48
EXPORTS OF MERCHANDISE:			
Total	Dollars	70,971,780	144,375,726
Per capita [2]	Dollars	13.37	6.23
IMPORTS OF GOLD AND SILVER:			
Gold	Dollars	....	1,776,706
Silver	Dollars	....	2,852,086
EXPORTS OF GOLD AND SILVER:			
Gold [3]	Dollars	....	4,560,627
Silver [3]	Dollars	....	2,962,367
IMPORTS FOR CONSUMPTION, GROUPED ACCORDING TO DEGREE OF MANUFACTURE AND USES:			
Food and live animals	Dollars	....	32,718,076
Per cent of total	....	....	18.86
Crude articles for domestic industries	Dollars	....	18,105,147
Per cent of total	....	....	10.44
Articles manufactured wholly or partially for use as materials in the mechanic arts	Dollars	....	30,857,522
Per cent of total	....	....	17.78
Articles manufactured ready for consumption	Dollars	....	65,887,552
Per cent of total	....	....	37.97
Articles of voluntary use, luxuries, etc	Dollars	....	25,941,229
Per cent of total	....	....	14.95
Total imports	Dollars	....	173,509,528
DOMESTIC MERCHANDISE EXPORTED, GROUPED ACCORDING TO SOURCES OF PRODUCTION:			
Agricultural products	Dollars	25,590,534	108,605,713
Per cent of total	....	80.37	80.51
Manufactures	Dollars	2,493,755	17,580,456
Per cent of total	....	7.83	13.03
Mining	Dollars	....	167,090
Per cent of total	....	....	0.12
Forest	Dollars	2,228,863	4,590,747
Per cent of total	....	7.00	3.40
Fisheries	Dollars	1,098,511	2,824,818
Per cent of total	....	3.45	2.10
Miscellaneous	Dollars	429,240	1,131,409
Per cent of total	....	1.35	0.84
Total domestic exports	Dollars	31,840,903	134,900,233
IMPORTS BY GRAND DIVISIONS OF THE WORLD: [4]			
Europe	Dollars	46,857,960	124,954,302
Per cent of total	....	51.35	70.14
North America	Dollars	32,116,092	24,136,879
Per cent of total	....	35.19	13.55
South America	Dollars	....	16,647,637
Per cent of total	....	....	9.35
Asia	Dollars	11,560,810	10,315,486
Per cent of total	....	12.67	5.79
Oceania [5]	Dollars	142,969	1,401,340
Per cent of total	....	0.16	0.79
Africa	Dollars	551,496	682,151
Per cent of total	....	0.60	0.38
EXPORTS BY GRAND DIVISIONS OF THE WORLD: [5]			
Europe	Dollars	41,348,088	113,862,253
Per cent of total	....	58.26	74.96
North America	Dollars	27,208,618	24,722,610
Per cent of total	....	38.34	16.27

[1] Based on total imports to 1860; after that on imports for consumption only.
[2] Based on total exports to 1860; after that on domestic exports only.
[3] Gold and silver cannot be separately stated in domestic exports before 1864, but it is probable that the greater portion of the exports was gold. Gold and silver contained in ore are included under gold and silver since 1894.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

1860.	1870.	1880.	1890.	1900.	1903.
3,144,121	129,235,498	95,757,575	36,099,284	40,160,333	28,556,349
8,636	198,686	250,802	537,944	993,529	996,585
353,616,119	435,958,408	667,954,746	789,310,409	849,941,184	1,025,719,237
11.25	11.06	12.51	12.35	10.88	12.54
333,576,057	392,771,768	835,638,658	857,828,684	1,394,483,082	1,420,141,679
10.61	9.77	16.43	13.50	17.96	17.32
2,508,786	12,056,950	80,758,396	12,943,342	44,573,184	44,982,027
6,041,349	14,362,229	12,275,914	21,032,984	35,256,302	24,163,491
58,446,039	33,635,962	3,639,025	17,274,491	48,266,759	47,090,595
8,100,200	24,519,704	13,503,894	34,873,929	56,712,275	44,250,259
78,338,514	139,213,092	199,165,963	288,600,646	216,107,303	212,057,293
22.15	32.65	31.72	32.13	26.02	21.04
61,570,477	66,909,565	160,055,876	178,435,512	299,351,033	383,634,293
17.41	15.69	25.52	23.06	36.04	38.06
31,939,551	53,658,296	73,186,963	84,700,568	80,575,042	97,194,094
9.03	12.59	11.66	10.94	9.70	9.64
123,741,654	119,298,235	130,004,643	154,469,354	130,577,155	169,259,497
35.00	27.98	20.72	19.96	15.72	16.79
58,025,923	47,266,822	65,141,826	107,468,732	103,908,719	145,814,933
16.41	11.09	10.38	13.91	12.51	14.47
353,616,119	426,346,010	627,555,271	773,674,812	830,519,252	1,007,960,110
256,560,972	361,188,483	685,961,091	629,820,808	835,858,123	873,322,882
81.13	79.35	83.25	74.51	60.98	62.73
40,345,892	68,279,764	102,856,015	151,102,376	433,851,756	407,526,159
12.76	15.00	12.48	17.87	31.65	29.28
999,465	5,026,111	5,863,232	22,297,755	37,843,742	39,311,239
0.31	1.10	0.71	2.64	2.76	2.81
10,299,959	14,897,963	17,321,268	29,473,084	52,218,112	57,835,896
3.26	3.27	2.11	3.49	3.81	4.16
4,156,480	2,835,508	5,255,402	7,458,385	6,326,620	7,805,538
1.31	0.62	0.64	0.88	0.46	0.56
3,879,655	2,980,512	6,689,345	5,141,420	4,665,218	6,429,588
1.23	0.66	0.81	0.61	0.34	0.46
316,242,423	455,208,341	823,946,353	845,293,828	1,370,763,571	1,392,231,302
216,831,353	249,540,283	370,821,782	449,987,266	440,567,314	547,226,887
59.87	53.98	55.52	57.14	51.84	53.35
75,082,583	126,544,611	130,077,225	148,368,706	130,035,221	189,736,475
20.73	27.42	19.47	18.84	15.30	18.49
35,992,719	43,596,045	82,126,922	90,006,144	93,666,774	107,428,323
9.94	9.41	12.30	11.43	11.02	10.48
26,201,603	31,413,378	67,008,793	67,506,833	139,842,330	147,702,374
7.24	6.78	10.02	8.57	16.45	14.40
3,495,226	1,423,212	[6] 14,130,604	28,356,568	34,611,108	21,043,527
0.96	0.31	2.13	3.60	4.07	2.05
3,798,518	[7] 9,860,058	3,789,420	3,321,477	11,218,437	12,581,651
1.05	2.10	0.56	0.42	1.32	1.23
310,272,818	420,184,014	719,433,788	683,736,397	1,040,167,763	1,029,256,657
77.54	79.35	86.10	79.74	74.60	72.48
53,325,937	68,962,006	69,437,783	94,100,410	187,504,625	215,482,769
13.33	13.03	8.31	10.98	13.45	15.16

[4] In 1870 specie is included in totals, but excluded in following years.
[5] Hawaiian Islands not included since 1900.
[6] Includes "All other Spanish possessions."
[7] Includes "All other countries."

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

Area, Population, and Industries.	In	1800.	1850.
Exports by Grand Divisions of the World—Cont'd.			
South America	Dollars	....	9,076,724
Per cent of total	....	....	5.98
Asia	Dollars	1,177,846	3,051,720
Per cent of total	....	1.66	2.01
Oceania [1]	Dollars	14,112	208,129
Per cent of total	....	0.02	0.14
Africa	Dollars	1,110,374	977,284
Per cent of total	....	1.56	0.64
TRANSPORTATION OF FOREIGN COMMERCE:			
Imports—			
By sea { In American vessels	Dollars	....	139,657,043
By sea { In foreign vessels	Dollars	....	38,481,275
Total	Dollars	....	178,138,318
Share carried in American vessels	Per cent.	....	78.4
By land vehicles	Dollars	....	....
Total by land and sea	Dollars	....	178,138,318
Exports—			
By sea { In American vessels	Dollars	....	99,615,041
By sea { In foreign vessels	Dollars	....	52,283,679
Total	Dollars	....	151,998,720
Share carried in American vessels	Per cent.	....	65.4
By land vehicles	Dollars	....	....
Total by land and sea	Dollars	....	151,998,720
FOREIGN COMMERCE OF PRINCIPAL CUSTOMS DISTRICTS:			
Boston { Imports	Dollars	....	....
Boston { Exports	Dollars	....	....
New York { Imports	Dollars	....	....
New York { Exports	Dollars	....	....
Philadelphia { Imports	Dollars	....	....
Philadelphia { Exports	Dollars	....	....
Baltimore { Imports	Dollars	....	....
Baltimore { Exports	Dollars	....	....
New Orleans { Imports	Dollars	....	....
New Orleans { Exports	Dollars	....	....
San Francisco { Imports	Dollars	....	....
San Francisco { Exports	Dollars	....	....
FARM STATISTICS:			
Farms	Number.	....	1,449,073
Persons engaged in agriculture	Number.	....	....
Value of farms and farm property	Dollars	....	3,967,343,580
Value of farm products	Dollars	....	....
FARM ANIMALS:			
Total value	Dollars	....	544,180,516
Cattle	Number.	....	17,778,907
Horses	Number.	....	4,336,719
Sheep	Number.	....	21,773,220
Mules	Number.	....	559,331
Swine	Number.	....	30,354,213
PRODUCTION OF PRINCIPAL COMMODITIES:			
Wool	Pounds.	....	52,516,959
Wheat	Bushels	....	100,485,944
Corn	Bushels	....	592,071,104
Cotton	Bales	155,556	2,333,718
Cane-sugar	Tons	....	110,526
PRODUCTION OF PRINCIPAL MINERALS:			
Precious metals—			
Gold	Dollars	....	50,000,000
Silver	Dollars	....	50,000
Coal [6]	Tons	....	3,358,899
Petroleum	Gallons	....	....
Pig iron	Tons	....	563,755

[1] Hawaiian Islands not included since 1900.
[2] Includes "All other Spanish possessions."
[3] Includes "All other countries."
[4] Gold values.
[5] Does not include value of products fed to live stock.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

1860.	1870.	1880.	1890.	1900.	1903.
16,742,100	21,651,459	23,190,220	38,752,648	38,945,763	41,137,872
4.18	4.09	2.77	4.52	2.79	2.90
11,067,921	10,972,064	11,645,703	19,696,820	64,913,807	58,359,016
2.77	2.07	1.39	2.30	4.66	4.11
5,373,497	4,334,991	[2] 6,846,698	16,460,269	43,391,275	37,468,512
1.34	0.82	0.82	1.92	3.11	2.64
3,227,760	[3] 3,414,768	[2] 5,084,466	4,613,702	19,469,849	38,436,853
0.84	0.64	0.61	0.54	1.79	2.71
228,164,855	153,237,077	149,317,368	124,948,948	104,304,940	123,666,832
134,001,399	309,140,510	503,494,913	623,740,100	701,223,735	835,844,210
362,166,254	462,377,587	652,812,281	748,689,048	805,528,675	959,511,042
63.0	33.1	22.9	16.7	12.9	12.9
...	...	15,142,465	40,621,361	44,412,509	66,208,195
362,166,254	462,377,587	667,954,746	789,310,409	849,941,184	1,025,719,237
279,082,902	199,732,324	109,029,209	77,502,138	90,779,252	91,028,200
121,039,394	329,786,978	720,770,521	747,376,644	1,193,220,689	1,190,262,178
400,122,296	529,519,302	829,799,730	824,878,782	1,283,999,941	1,281,290,378
70.0	37.7	13.1	9.4	7.1	7.1
...	...	5,838,928	32,949,902	110,483,141	138,851,301
400,122,296	529,519,302	835,638,658	857,828,684	1,394,483,082	1,420,141,679
39,333,684	47,484,060	68,503,136	62,876,666	72,195,939	86,310,586
12,747,945	14,126,429	59,238,241	71,201,944	112,195,555	88,126,444
231,310,086	281,048,813	459,937,153	516,426,693	537,237,282	618,705,662
80,047,978	196,614,746	392,560,090	349,051,791	518,834,471	505,829,694
14,611,934	14,483,211	35,944,500	53,936,315	51,866,002	59,995,431
5,526,967	16,927,610	49,649,693	37,410,683	78,406,031	73,531,968
9,781,205	19,512,468	19,945,989	13,140,203	19,045,279	27,803,167
8,940,100	14,510,733	76,253,566	73,983,693	115,530,378	81,704,497
20,636,316	14,377,471	10,611,353	14,658,163	17,490,811	28,880,744
108,164,812	107,586,952	90,442,019	108,126,891	115,858,764	149,072,519
7,367,016	15,982,549	35,221,751	48,751,223	47,869,628	36,454,283
4,868,090	13,991,781	32,358,929	36,876,091	40,368,288	33,502,616
2,044,077	2,659,985	4,008,907	4,564,641	5,739,657	...
...	5,922,471	7,713,875	8,565,926	10,438,219	...
7,980,493,060	[4] 8,944,857,749	12,180,501,538	16,082,267,689	20,514,001,838	...
...	[4] 1,958,030,927	2,212,540,927	2,460,107,454	[5] 3,764,177,706	...
1,089,329,915	1,524,960,149	1,576,917,556	2,418,766,028	2,228,123,134	3,102,515,540
25,616,019	25,484,100	33,258,000	52,801,907	43,902,414	61,764,433
6,249,174	8,248,800	11,201,800	14,213,837	13,537,524	16,557,373
22,471,275	40,853,000	40,765,900	44,336,072	41,883,065	63,964,876
1,151,148	1,179,500	1,729,500	2,331,027	2,086,027	2,728,088
33,512,867	26,751,400	34,034,100	51,602,780	37,079,356	46,922,624
60,264,913	162,000,000	232,500,000	276,000,000	288,636,621	287,450,000
173,104,924	235,884,700	498,549,868	399,262,000	522,229,505	637,821,835
838,792,740	1,094,255,000	1,717,434,543	1,489,970,000	2,105,102,516	2,244,176,925
4,861,292	3,114,592	5,761,252	7,311,322	9,433,416	10,727,559
119,040	46,800	92,802	136,503	149,191	293,397
46,000,000	50,000,000	36,000,000	32,845,000	79,171,000	74,425,340
150,000	16,000,000	39,200,000	70,485,714	74,533,495	73,076,106
18,513,123	32,863,000	63,822,830	140,866,931	240,789,309	...
[7] 21,000,000	220,951,290	1,104,017,166	1,924,552,224	2,661,233,568	...
821,223	1,665,179	3,835,191	9,202,703	13,789,242	18,009,252

[6] Pennsylvania anthracite shipments only from 1820 to 1867; entire coal product from 1868 to 1902.

[7] In addition to this it is estimated that 10,000,000 barrels ran to waste in and prior to 1862 for want of a market.

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

Area, Population, and Industries.	In	1800.	1850.
Production of Principal Minerals—Continued.			
Steel	Tons		
Copper	Tons		650
Total value all mineral production in U. S.	Dollars		
MANUFACTURING INDUSTRIES OF THE U. S.:			
Manufacturing establishments [1]	Number		123,025
Average employees [1]	Number		957,059
Wages and salaries paid [1]	Dollars		236,755,464
Value of products [1]	Dollars		1,019,106,616
MANUFACTURES OF IRON AND STEEL: [1]			
Establishments	Number		
Wages and salaries paid	Dollars		
Value of products	Dollars		
Imports	Dollars		20,145,067
Exports	Dollars	52,144	1,953,702
TIN PLATES:			
Imports	Pounds		
Production	Lbs., net		
MANUFACTURES OF COTTON: [3]			
Establishments [1]	Number		1,094
Wages and salaries paid [1]	Dollars		
Value of products [1]	Dollars		61,869,184
Exports	Dollars		4,734,424
Imports	Dollars		20,108,719
COTTON MOVEMENT:			
Domestic cotton taken by United States mills	Bales		595,000
Exports of domestic cotton	Pounds		635,381,607
	Dollars		71,984,616
Raw cotton imported	Pounds	4,239,987	269,114
MANUFACTURES OF WOOL: [3]			
Establishments [1]	Number		1,675
Wages and salaries paid [1]	Dollars		
Value of products [1]	Dollars		48,608,779
Imports	Dollars		19,620,619
Raw wool imported	Pounds		18,695,294
MANUFACTURES OF SILK:			
Establishments [1]	Number		67
Wages and salaries paid [1]	Dollars		
Value of products [1]	Dollars		1,809,476
Imports	Dollars		17,639,624
Raw silk imported	Pounds		
Imports of crude rubber	Pounds		
SUGAR:			
Imports	Pounds		218,430,764
	Dollars		7,555,603
Average cost per pound in foreign countries	Cents		3.46
Wholesale prices of granulated, at New York	Cents		
Total consumption	Tons		239,409
Consumption per capita	Pounds		23.1
COFFEE:			
Imports	Pounds		145,272,687
	Dollars		11,234,835
Average import price per pound at New York	Cents		7.6
Consumption per capita [6]	Pounds		5.60
TEA:			
Imports	Pounds		29,872,654
	Dollars		4,719,232
Average import price per pound at New York	Cents		14.1
Consumption per capita [6]	Pounds		1.22
RAILWAYS:			
In operation	Miles		9,021
Passengers carried	Number		
Freight carried one mile	Tons		

[1] No official figures in other than census years.

[2] 1891, last six months.

[3] Does not include hosiery and knit goods.

AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

1860.	1870.	1880.	1890.	1900.	1903.
....	68,750	1,247,335	4,277,071	10,188,329	....
7,200	12,600	27,000	115,966	270,588	....
....	218,598,994	369,319,000	619,648,925	1,063,620,548	....
140,433	252,148	253,852	355,415	512,734	....
1,311,246	2,053,996	2,732,595	4,712,622	5,719,137	....
378,878,966	775,584,343	947,953,795	2,283,216,529	2,735,430,848	....
1,885,861,676	4,232,325,442	5,369,579,191	9,372,437,283	13,039,279,566	....
....	808	1,005	719	725	....
....	40,514,981	55,476,785	95,736,192	134,739,004	....
....	207,208,696	296,557,685	478,687,519	835,759,034	....
26,158,235	40,273,682	71,266,699	41,679,591	20,478,728	51,617,312
5,870,114	13,483,163	14,716,524	25,542,208	121,913,548	96,642,467
....	150,932,768	379,902,880	680,060,925	147,963,804	109,913,293
....	....	....	[2] 2,236,743	677,969,600	....
1,091	956	756	905	1,055	....
23,940,108	39,044,132	45,614,419	69,489,272	94,039,951	....
115,681,774	177,489,739	192,090,110	267,981,724	339,200,320	....
10,934,796	3,787,282	9,981,418	9,999,277	24,003,087	32,216,304
33,215,541	23,380,053	29,929,366	29,918,055	41,296,239	52,462,755
979,000	857,000	1,795,000	2,325,000	3,644,000	3,924,000
1,767,686,338	958,558,523	1,822,061,114	2,471,799,853	3,100,583,188	3,543,043,022
191,806,555	227,074,624	211,535,905	250,968,792	241,832,737	316,180,429
2,005,529	1,698,133	3,547,792	8,606,049	67,398,521	74,874,426
1,476	3,208	2,330	1,693	1,414	....
11,699,630	35,928,150	40,687,612	58,397,470	64,389,312	....
73,454,000	199,257,262	238,085,686	270,527,511	296,990,484	....
43,141,988	34,490,668	33,911,093	56,582,432	16,164,446	19,546,385
([4])	49,230,199	128,131,747	105,431,285	155,928,455	177,137,796
139	86	382	472	483	....
1,050,224	1,942,286	9,146,705	17,762,441	20,982,194	....
6,607,771	12,210,662	41,033,045	87,298,454	107,256,258	....
32,726,134	23,904,048	32,188,690	38,686,374	30,894,373	35,963,552
....	583,589	2,562,236	7,347,909	13,043,714	15,270,600
....	9,624,098	16,826,099	33,842,374	49,377,138	55,010,571
694,838,197	1,196,773,569	1,829,291,684	2,934,011,560	4,018,086,530	[5] 4,216,108,106
31,078,970	56,923,745	80,087,720	96,094,532	100,250,974	72,088,973
4.38	4.95	4.18	3.28	2.49	1.71
....	13.51	9.80	6.27	5.32	4.64
428,785	607,834	956,784	1,476,377	2,219,847	2,549,643
30.5	35.3	42.9	52.8	65.2	71.1
202,144,733	235,256,574	446,850,727	499,159,120	787,991,911	915,086,380
21,883,797	24,234,879	60,360,769	78,267,432	52,467,943	59,200,749
10.8	10.3	13.5	16.0	6.7	6.5
5.79	6.00	8.78	7.83	9.81	10.79
31,696,657	47,408,481	72,162,936	83,886,829	84,845,107	108,574,905
8,915,327	13,863,273	19,782,631	12,317,493	10,558,110	15,659,229
26.3	29.4	27.4	15.0	12.4	14.5
0.84	1.10	1.39	1.33	1.09	1.30
30,626	52,922	93,262	166,703	194,334	....
....	....	....	520,439,082	584,695,935	....
....	....	....	79,192,985,125	141,162,109,413	....

[4] Quantity not stated.

[5] Does not include sugar from Hawaii and Porto Rico.

[6] Consumption per capita based on net imports.

SUMMARY OF PROGRESS OF THE UNITED STATES IN ITS

Area, Population, and Industries.	In	1800.	1850.
Railways—Continued.			
Freight rates per ton per mile	Cents		
Passenger cars	Number		
Freight cars	Number		
AMERICAN VESSELS:			
Built	Tons	106,261	279,255
Engaged in foreign trade	Tons	669,921	1,585,711
Engaged in domestic trade	Tons	301,919	1,949,743
Engaged in commerce of Great Lakes	Tons		108,266
Vessels passing through the Sault Ste. Marie Canal	Tonnage		
FREIGHT RATES ON WHEAT, CHICAGO TO NEW YORK:			
Lake and canal [1]	Cts. per bu.		
Lake and rail	Cts. per bu.		
All rail	Cts. per bu.		
CONSUMPTION OF WINES AND LIQUORS:			
Wines—			
Consumption	Gallons		6,315,871
Consumption per capita	Gallons		0.27
Malt liquors—			
Consumption	Gallons		36,563,009
Consumption per capita	Gallons		1.58
Distilled spirits—			
Consumption	Gallons		51,833,473
Consumption per capita	Gallons		2.23
Total consumption of wines and liquors	Proof galls.		94,712,353
Total consumption per capita	Proof galls.		4.08
PRICES OF STAPLE COMMODITIES: [3]			
Pig iron, No. 1, foundry, per ton	Dollars		20.88
Steel rails, standard sections, per ton	Dollars		
Middling cotton, per pound [4]	Cents		12.34
Standard sheetings, per yard	Cents		7.87
Standard prints, per yard	Cents		10.62
Washed Ohio fleece wool, July 1—			
Fine	Cents		45
Medium	Cents		37
Coarse	Cents		30
COMMERCIAL FAILURES:			
Reported	Number		
Amount of liabilities	Dollars		
POST-OFFICE STATISTICS:			
Post-offices	Number	903	18,417
Receipts of Post-office Department	Dollars	280,804	5,499,985
Telegraph messages sent [5]	Number		
Newspapers and periodicals published	Number		2,526
PUBLIC SCHOOLS:			
Pupils enrolled	Number		
Average daily attendance	Number		
Salaries paid superintendents and teachers	Dollars		
Total expenditures	Dollars		
STUDENTS IN COLLEGES, UNIVERSITIES, AND SCHOOLS OF TECHNOLOGY:			
Men	Number		
Women	Number		
Total	Number		
Patents issued	Number		993
Immigrants arrived	Number		310,004

[1] Including canal tolls under 1882, but not Buffalo transfer charges.
[2] For domestic consumption; local rate for exports only 9.08 cents in 1900.
[3] At Philadelphia.
[4] Net prices.
[5] Western Union to 1885; includes Postal Telegraph 1885 to date.
[6] Figures from 1870 to date; from Rowell's Newspaper Directory.

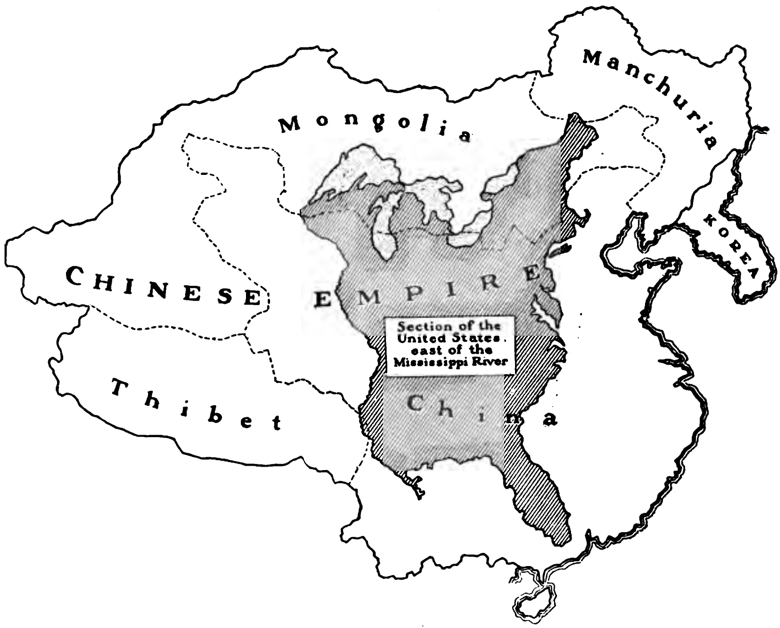
AREA, POPULATION, AND MATERIAL INDUSTRIES—Continued.

1860.	1870.	1880.	1890.	1900.	1903.
....	....	....	93	75	....
....	....	12,788	21,664	26,786	....
....	....	544,185	1,099,205	1,350,258	....
214,797	276,953	157,409	294,122	393,790	436,152
2,546,237	1,516,800	1,352,810	946,695	826,694	888,776
2,807,631	2,729,707	2,715,224	3,477,802	4,338,145	5,198,569
467,774	684,704	605,102	1,063,063	1,565,587	1,902,698
403,657	690,826	1,734,890	8,454,435	22,315,834	27,736,444
24.83	17.11	12.27	5.85	4.42	5.44
....	22.0	15.7	8.5	5.05	6.17
....	33.3	19.9	14.31	[2] 9.98	11.33
11,059,141	12,225,067	28,329,541	28,956,981	30,427,491	39,413,201
0.35	0.32	0.56	0.46	0.40	0.49
101,346,669	204,756,156	414,220,165	855,792,335	1,221,500,160	1,449,879,952
3.22	5.31	8.26	13.67	16.01	18.04
89,968,651	79,895,708	63,526,694	87,829,562	97,248,382	117,252,148
2.86	2.07	1.27	1.40	1.27	1.46
202,374,461	296,876,931	506,076,400	972,578,878	1,349,176,033	1,606,545,301
6.44	7.70	10.09	15.53	17.68	19.99
22.75	33.25	28.50	18.40	19.98	19.92
....	106.75	67.50	31.75	32.29	28.00
11.00	23.98	11.51	11.07	9.25	11.18
8.73	14.58	8.51	7.00	6.05	6.25
9.50	12.41	7.41	6.00	5.00	5.00
55	46	46	33	28½	31½
50	45	48	37	31½	31½
40	43	42	29	27½	27
3,676	3,546	4,735	10,907	10,774	12,069
79,807,000	88,242,000	65,752,000	189,856,964	138,495,673	155,444,185
28,498	28,492	42,989	62,401	76,688	74,169
8,518,067	19,772,221	33,315,479	60,882,097	102,354,579	134,224,443
....	9,157,646	29,215,509	63,258,762	79,696,227	91,391,443
4,051	[6] 5,871	9,723	16,948	20,806	20,485
....	6,871,522	6,867,505	12,722,581	15,503,110	....
....	4,077,347	6,144,143	8,153,635	10,632,772	....
....	37,832,566	55,942,972	91,836,484	137,687,746	....
....	63,396,666	78,094,687	140,506,715	214,964,618	....
....	....	....	44,926	72,159	....
....	....	....	10,761	26,764	....
....	....	[7] 38,227	55,687	98,923	....
4,778	13,333	13,947	26,292	26,499	31,699
[8] 150,237	[9] 387,203	457,257	455,302	448,572	857,046

[7] Figures for the year 1880 are for the calendar year preceding the fiscal year, and include non-resident graduates; figures of later years are exclusive of non-resident graduate students.

[8] Calendar year.

[9] Years ending June 30 to date.



COMPARISON OF THE CHINESE EMPIRE WITH EASTERN UNITED STATES.

—*Booklover's Magazine.*

CHAPTER XI.

THE DEPARTMENTS OF THE FEDERAL GOVERNMENT.

The following is a brief résumé of the work carried on by the Departments of the Government service, and in many cases the individual bureaus and divisions are noted. Information germane to the work of the bureaus, etc., is cheerfully given.

THE DEPARTMENT OF JUSTICE.

The Attorney-General is the head of the Department of Justice and the chief law officer of the Government. He represents the United States in matters involving legal questions; he gives his advice and opinion, when they are required by the President or by the heads of the other Executive Departments, on questions of law arising in the administration of their respective Departments; he exercises a general superintendence and direction over United States attorneys and marshals in all judicial districts in the States and Territories; and he provides special counsel for the United States whenever required by any Department of the Government.

THE DEPARTMENT OF STATE.

The Secretary of State is charged, under the direction of the President, with the duties appertaining to correspondence with the public ministers and the consuls of the United States, and with the representatives of foreign powers accredited to the United States; and to negotiations of whatever character relating to the foreign affairs of the United States. He is also the medium of correspondence between the President and the chief executives of the several States of the United States; he has the custody of the Great Seal of the United States, and countersigns and affixes such seal to all executive proclamations, to various commissions, and to warrants for the extradition of fugitives from justice. He is regarded as the first in rank among the members of the Cabinet.

The Secretary of State is also the custodian of the treaties made with foreign States, and of the laws of the United States. He grants and issues passports, and exequaturs to foreign consuls in the United States are issued through his office. He publishes the laws and resolutions of Congress, amendments to the Constitution, and proclamations declaring the admission of new States into the Union. He is also charged with certain annual reports to Congress relating to commercial information received from diplomatic and consular officers of the United States.

THE DEPARTMENT OF THE TREASURY.

The Secretary of the Treasury is charged by law with the management of the national finances. He prepares plans for the improvement of the revenue and for the support of the public credit; superintends the collection of the revenue, and directs the forms of keeping and rendering public accounts and of making returns; grants warrants for all moneys drawn from the Treasury in pursuance of appropriations made by law, and for the payment of moneys into the Treasury; and annually submits to Congress estimates of the probable revenues and disbursements of the Government. He also controls the construction of public buildings; the coinage and printing of money; the administration of the Life-Saving, Revenue-Cutter, and the Public Health and Marine-Hospital branches of the public service, and furnishes generally such information as may be required by either branch of Congress on all matters pertaining to the foregoing.

THE DEPARTMENT OF WAR.

The Secretary of War is head of the War Department, and performs such duties as are required of him by law or may be enjoined upon him by the President concerning the military service. He is charged by law with the supervision of all estimates of appropriations for the expenses of the Department, including the military establishment; of all purchases of army supplies: of all expenditures for the support, transportation, and maintenance of the Army, and of such expenditures of a civil nature as may be placed by Congress under his direction. He also has supervision of the United States Military Academy at West Point and of military education in the Army, of the Board of Ordnance and Fortification, of the various battlefield commissions, and of the publication of the official Records of the War of the Rebellion. He has charge of all matters relating to national defense and seacoast fortifications, army ordnance, river and harbor improvements, the prevention of obstruction to navigation, and the establishment of harbor lines, and all plans and locations of bridges authorized by Congress to be constructed over the navigable waters of the United States require his approval. He also has charge of the establishment or abandonment of military posts, and of all matters relating to leases, revocable licenses, and all other privileges upon lands under the control of the War Department.

THE GENERAL STAFF.

The General Staff Corps was organized under the provisions of an act of Congress approved February 14, 1903. Its principal duties are to prepare plans for the national defense and for the mobilization of the military forces in time of war; to investigate and report upon all questions affecting the efficiency of the Army and its state of preparation for military operations; to render professional aid and assistance to the Secretary of War and to general officers and other superior commanders and to act as their agents in informing and co-ordinating the action of all the different officers who are subject to the supervision of the Chief of Staff, and to perform such other military duties not otherwise assigned by law as may be from time to time prescribed by the President. The Chief of Staff, under direction of the President, or of the Secretary of War under the direction of the President, has supervision of all troops of the line and of the Adjutant-General's, Inspector-General's, Judge-Advocate-General's, Quartermaster's, Subsistence, Medical, Pay, and Ordnance Departments, the Corps of Engineers and the Signal Corps, and performs such other military duties not otherwise assigned by law as may be assigned to him by the President. Duties formerly prescribed by statute for the Commanding General of the Army as a member of the Board of Ordnance and Fortification and of the Board of Commissioners of the Soldiers' Home are performed by the Chief of Staff or some other officer designated by the President.

SOME OF THE MILITARY BUREAUS.

The chiefs of the military bureaus of the War Department are officers of the Regular Army of the United States and part of the military establishment, viz.:

The Adjutant-General's Department is the bureau of orders and records of the Army. Orders and instructions emanating from the War Department and all regulations are issued by the Secretary of War through the Chief of Staff, and are communicated to troops and individuals in the military service through the Adjutant-General. His office is the repository for the records of the War Department which relate to the personnel of the permanent military establishment and militia in the service of the United States, to the military history of every commissioned officer and soldier thereof, and to the movements and operation of troops. The records of all appointments, promotions, resignations, deaths, and other casualties in the Army, the preparation and distribution of commissions, and the compilation and issue of the Army Register and of information concerning examinations for appointment and promotions pertain to the Adjutant-General's Office. The Adjutant-General is charged, under the direction of the Secretary of War, with the management of the recruiting service, the communication of instructions to officers detailed to visit encampments of militia, and the digesting, arranging, and preserving of their reports; also

the preparation of the annual returns of the militia required by law to be submitted to Congress.

The Quartermaster-General, aided by his assistants, provides transportation for the Army; also clothing and equipage, horses, mules, and wagons, vessels, forage, stationery, and other miscellaneous quartermaster stores and property for the Army, and of clothing and equipage for the militia; constructs necessary buildings, wharves, roads, and bridges at military posts, and repairs the same; furnishes water, heating and lighting apparatus; pays guides, spies, and interpreters, and is in charge of national cemeteries.

The Chief of Engineers commands the Corps of Engineers, which is charged with all duties relating to construction and repair of fortifications, whether permanent or temporary; with all works of defense; with all military roads and bridges, and with such surveys as may be required for these objects, or the movement of armies in the field. It is also charged with the river and harbor improvements, with military and geographical explorations and surveys, with the survey of the lakes, and with any other engineering work specially assigned to the corps by acts of Congress or orders of the Secretary of War.

The Chief of Ordnance commands the Ordnance Department, the duties of which consist in providing, preserving, distributing, and accounting for every description of artillery, small arms, and all the munitions of war which may be required for the fortresses of the country, the armies in the field, and for the whole body of the militia of the Union. In these duties are comprised those of determining the general principles of construction and of prescribing in detail the models and forms of all military weapons employed in war. They comprise also the duty of prescribing the regulations for the proof and inspection of all these weapons, for maintaining uniformity and economy in their fabrication, for insuring their good quality, and for their preservation and distribution.

The Chief Signal Officer is charged with the supervision of all military signal duties, and of books, papers, and devices connected therewith, including telegraph and telephone apparatus and the necessary meteorological instruments for use on target ranges and other military uses; the construction, repair, and operation of military telegraph lines, and the duty of collecting and transmitting information for the Army by telegraph or otherwise, and all other duties usually pertaining to military signaling.

THE DEPARTMENT OF AGRICULTURE.

The Secretary of Agriculture is charged with the supervision of all public business relating to the agricultural industry. He appoints all the officers and employees of the Department, with the exception of the Assistant Secretary and the Chief of the Weather Bureau, who are appointed by the President, and directs the management of all the bureaus, divisions, and offices embraced in the Department. He exercises advisory supervision over agricultural experiment stations deriving support from the National Treasury. He controls the import and export of cattle, including cattle-carrying vessels, and directs interstate quarantine when rendered necessary by contagious cattle diseases. His duties and powers include the preservation, distribution, and introduction of birds and animals, game birds and other wild birds and animals in the United States, and the protection of wild game animals and wild birds in the district of Alaska. He is charged generally with carrying out the chief purpose of the Department, which is "to acquire and diffuse among the people of the United States useful information on subjects connected with agriculture, in the most comprehensive sense of that word, and to procure, propagate, and distribute among the people new and valuable seeds and plants."

THE WEATHER BUREAU.

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, has charge of the forecasting of weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature

and rain-fall conditions for the cotton interests; the display of frost and cold-wave signals; the distribution of meteorological information in the interests of agriculture and commerce, and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States or as are essential for the proper execution of the foregoing duties.

THE BUREAU OF ANIMAL INDUSTRY.

The Bureau of Animal Industry makes investigations as to the existence of dangerous communicable diseases of live stock; superintends the measures for their extirpation, and makes original investigations as to the nature and prevention of such diseases. It inspects live stock and their products slaughtered for food consumption; has charge of the inspection of import and export animals, of the inspection of vessels for the transportation of export animals, and of the quarantine stations for imported neat cattle, other ruminants, and swine; generally supervises the interstate movement of animals and reports on the condition and means of improving the animal industries of the country. It makes special investigations in regard to dairy subjects, inspects and certifies dairy products for export, and supervises the manufacture and interstate commerce of renovated butter.

BUREAU OF CHEMISTRY.

The Bureau of Chemistry makes investigations of fertilizers, and agricultural products, and such analyses as pertain in general to the interests of agriculture. It investigates the composition and adulteration of foods and the composition of field products in relation to their nutritive value and to the constituents which they derive from the soil, fertilizers, and the air. It inspects imported food products and excludes from entry those injurious to health. It inspects food products exported to foreign countries where physical and chemical tests are required for such products. It co-operates with the chemists of the agricultural experiment stations in all matters pertaining to the relations of chemistry to agricultural interests. It also co-operates with the other scientific divisions of the Department in all matters relating to chemistry, and conducts investigations of a chemical nature for other Departments of the Government at the request of their respective Secretaries.

BUREAU OF STATISTICS.

The statistician collects information as to crop production and the numbers and status of farm animals, through a corps of county and township correspondents, traveling agents, and other agencies, and obtains similar information from foreign countries through special agents, assisted by consular, agricultural, and commercial authorities. He records, tabulates, and co-ordinates statistics of agricultural production, distribution, and consumption, the authorized data of governments, institutes, societies, boards of trade, and individual experts; and issues a monthly crop report for the information of producers and consumers.

DIVISION OF FOREIGN MARKETS.

The division of foreign markets has for its object the extension of the agricultural export trade of the United States. It investigates the requirements of foreign markets, studies the conditions of demand and supply as disclosed by the records of production, importation, and exportation, inquires into the obstacles confronting trade extension, and disseminates through printed reports and otherwise the information collected.

OFFICE OF EXPERIMENT STATIONS.

The Office of Experiment Stations represents the Department in its relations to the agricultural colleges and experiment stations, which are now in operation in all the States and Territories, and directly manages the experiment stations in Alaska, Hawaii, and Porto Rico. It seeks to promote the interests of agricultural education and investigation throughout the United States. It collects and disseminates general information regarding the colleges and stations, and publishes accounts of agricultural investigations at home and abroad. It also indicates lines of inquiry, aids in the conduct of co-operative experiments, reports upon the expenditures and work of the stations, and in general furnishes them with such advice and assistance as will best promote the purposes for which they were established. It is also charged with investigations on the nutritive value and economy of human

foods and on irrigation and agricultural engineering, which are largely conducted in co-operation with the colleges and stations.

DIVISION OF ENTOMOLOGY.

The entomologist obtains and disseminates information regarding injurious insects; investigates insects sent him in order to give appropriate remedies; conducts investigations of this character in different parts of the country, and mounts and arranges specimens for illustrative and museum purposes.

DIVISION OF BIOLOGICAL SURVEY.

The division of biological survey studies the geographic distribution of animals and plants, and maps the natural life zones of the country; it also investigates the economic relations of birds and mammals, recommends measures for the preservation of beneficial and the destruction of injurious species, and has been charged with carrying into effect the provisions of the Federal law for the importation and protection of birds, contained in the act of Congress of May 25, 1900.

BUREAU OF FORESTRY.

The Bureau of Forestry gives practical assistance to farmers, lumbermen, and others in the conservative handling of forest lands; investigates methods and trees for planting in the treeless West, and gives practical assistance to tree planters; studies commercially valuable trees to determine their special uses in forestry; tests the strength and durability of construction timbers and railroad ties; investigates forest fires, grazing, and other forest problems; and makes plans for practical forestry in the national forest reserves at the request of the Secretary of the Interior.

BUREAU OF PLANT INDUSTRY.

The Bureau of Plant Industry studies plant life in all its relations to agriculture. It includes vegetable pathological and physiological investigations, botanical investigations and experiments, pomological investigations, grass and forage plant investigations, experimental gardens and grounds, the Arlington experimental farm, Congressional seed distribution, seed and plant introduction, and tea-culture experiments.

VEGETABLE PATHOLOGICAL AND PHYSIOLOGICAL INVESTIGATIONS.

These investigations have for their objects the study of diseases of agricultural crops and economic plants, nutrition of plants, rotation of crops, and the general application of the principles of pathology and physiology to agriculture, the problems of crop improvement, and the production of better varieties of agricultural plants and of crops resistant to disease by means of breeding and selection.

BOTANICAL INVESTIGATIONS AND EXPERIMENTS.

This office investigates botanical problems, including the purity and value of seeds; methods of controlling the spread of weeds and preventing their introduction into this country; the injurious effects and antidotes in the case of poisonous plants; the native plant resources of the country, and other phases of economic botany.

GRASS AND FORAGE PLANT INVESTIGATIONS.

This office studies the natural history, geographical distribution, and uses of grasses and forage plants, as well as their adaptation to special soils and climates; introduces promising foreign varieties, and investigates the methods of cultivation of native and foreign sorts.

POMOLOGICAL INVESTIGATIONS.

This branch of the Bureau collects and distributes information in regard to the fruit interests of the United States; investigates the habits and peculiar qualities of fruits; their adaptability to various soils and climates, and conditions of culture. It studies the methods of harvesting, handling, and storing fruits, with a view to improving our own markets and extending them into foreign countries.

EXPERIMENTAL GARDENS AND GROUNDS.

This branch is charged with the care and ornamentation of the parks surrounding the Department buildings; with the duties connected with the conservatories and gardens, and with the testing and propagating of economic plants. It carries on investigations for the purpose of determining the best methods of improving the

culture of plants under glass, and other lines of investigation connected with intensive horticulture.

CONGRESSIONAL SEED DISTRIBUTION.

This office is charged with the purchase and distribution of valuable seed. The seeds are distributed in allotments to Senators, Representatives, Delegates in Congress, and the agricultural experiment stations, and also by the Secretary of Agriculture, as provided for by the law.

SEED AND PLANT INTRODUCTION.

This work has for its object the securing from all parts of the world of seeds and plants of new and valuable agricultural crops adapted to different parts of the United States.

ARLINGTON EXPERIMENTAL FARM.

The experiment farm is designed ultimately to become an adjunct to all branches of the Department. It will carry on investigations in the testing of agricultural crops, fruits, and vegetables.

TEA CULTURE EXPERIMENTS.

This branch of the Bureau has for its object the study of tea with a view to producing it in this country. Experiments are conducted in tea culture, and methods of growing, curing, and handling the tea are being worked out. The work is carried on at Summerville, S. C., and at Pierce, Texas.

BUREAU OF SOILS.

The Bureau of Soils has for its object the investigation of soils in their relation to crops, the mapping of soils, the investigation, mapping, and reclamation of alkali lands, and investigations of the growth, curing, and fermentation of tobacco.

OFFICE OF PUBLIC-ROAD INQUIRIES.

The Office of Public-Road Inquiries collects information concerning the systems of road management throughout the United States, conducts and promotes investigations and experiments regarding the best methods of road making and road-making materials, and prepares publications on this subject.

DIVISION OF PUBLICATIONS.

The division of publications edits all publications of the Department, including Farmers' Bulletins and other agricultural reports ordered printed by the Congress, with the exception of those issued by the Weather Bureau. It supervises all printing, binding, and illustration work of the Department. It directs the distribution of publications with the exception of those turned over by law to the Superintendent of Documents for sale at the price fixed by him; issues, in the form of press notices, official information of interest to agriculturists, and distributes to agricultural and other periodicals and writers synopses of Department publications.

THE POST-OFFICE DEPARTMENT.

The Postmaster-General has the direction and management of the Post-office Department. He appoints all officers and employees of the Department, except the four Assistant Postmasters-General, who are appointed by the President, by and with the advice and consent of the Senate; appoints all postmasters whose compensation does not exceed $1,000; makes postal treaties with foreign Governments, by and with the advice and consent of the President, awards and executes contracts, and directs the management of the domestic and foreign mail service.

THE DEPARTMENT OF THE NAVY.

The Secretary of the Navy performs such duties as the President of the United States, who is Commander in Chief, may assign him, and has the general superintendence of construction, manning, armament, equipment, and employment of vessels of war.

BUREAU OF NAVIGATION.

The duties of the Bureau of Navigation comprise all that relates to the promulgation, record, and enforcement of the Secretary's orders to the fleets and to the officers of the Navy, except such orders as pertain to the Office of the Secretary; the education of officers and men, including the Naval Academy and technical schools for officers (except the War College and Torpedo School), the apprentice establishment, and schools for the technical education of enlisted men, and to the supervision

and control of the Naval Home, Philadelphia; the enlistment and discharge of all enlisted persons, including appointed petty officers for general and special service. It controls all rendezvous and receiving ships, and provides transportation for all enlisted persons and appointed petty officers; establishes the complement of the crews of all vessels in commission; keeps the records of service of all squadrons, ships, officers, and men, and prepares the annual Naval Register for publication; has under its direction the preparation, revision, and enforcement of all tactics, drill books, signal codes, cipher codes, and the uniform regulations.

BUREAU OF YARDS AND DOCKS.

The duties of the Bureau of Yards and Docks comprise all that relates to the planning, construction, and maintenance of all docks (including dry docks), wharves, slips, piers, quay walls, and buildings of all kinds, for whatever purpose needed, within the limits of the navy-yards, but not of hospitals and magazines outside of those limits, nor of buildings for which it does not estimate. It repairs and furnishes all buildings, stores and offices in the several navy-yards, and is charged with the purchase, sale, and transfer of all land and buildings connected with the navy-yards; has under its sole control the general administration of the navy-yards; provides and has sole control of all landings, derricks, shears, cranes, sewers, dredging, railway tracks, cars, and wheels, trucks, grading, paving, walks, shade trees, inclosure walls and fences, ditching, reservoirs, cisterns, fire engines, and apparatus, all watchmen, and all things necessary, including labor, for the cleaning of the yards and the protection of the public property.

BUREAU OF EQUIPMENT.

The duties of the Bureau of Equipment comprise all that relates to the equipment of all vessels with rigging, sails, anchors, yeomen's stores, furniture not provided by other bureaus, navigation stores and supplies of all kinds, including nautical and navigating instruments and books, stationery, and blank books for commanding and navigating officers ashore and afloat, binnacles, flags, signal lights, running lights, and standing lights on board vessels, including all electrical apparatus for lighting purposes and searchlights, logs, leads, lines, and glasses, log books, ships' libraries, illuminating oil for all purposes, except that used in the engineer department of steamers, and fuel for steamers, the ropewalks, and the shops for making anchors and cables, rigging, sails, galleys, and cooking utensils, the Naval Observatory, Nautical Almanac, compass offices, and pilotage. It has under its control the Hydrographic Office, the collection of foreign surveys, publication and supply charts, sailing directions, and nautical works, and the dissemination of nautical and hydrographic information to the Navy and mercantile marine.

BUREAU OF ORDNANCE.

The duties of the Bureau of Ordnance comprise all that relates to the torpedo station, naval proving grounds, and magazines on shore; to the manufacture of offensive and defensive arms and apparatus (including torpedoes), all ammunition and war explosives; procures all machinery, apparatus, equipment, material, and supplies required by or for use with the above; recommends the armament to be carried by vessels of the Navy; the material, kind, and quality of the armor; the interior dimensions of revolving turrets and their requirements as regards rotation. It fixes, within the carrying power of vessels as determined by the Bureau of Construction and Repair, the location and command of the armament, and distributes the thickness of the armor; inspects the installation of the permanent fixtures of the armament and its accessories on board ship, and the methods of storing, handling, and transporting ammunition and torpedoes; designs and constructs turret ammunition hoists; determines the requirements of all ammunition hoists, and the method of construction of armories and ammunition rooms on board ship, and in conjunction with the Bureau of Construction and Repair, determines upon their location and that of ammunition hoists. It installs the armament and its accessories which are not permanently attached to any portion of the structure of the hull, excepting turret guns, turret mounts, and ammunition hoists, etc.; has cognizance of all electrically operated ammunition hoists, rammers, and gun-elevating gear which are in turrets, of electric range finders, of electric training and elevating gear for gun mounts not in turrets, of electrically operated air

compressors for charging torpedoes, and of all battle-order and range transmitters and indicators; designs internal arrangements of buildings at navy-yards where ordnance work is performed; designs, erects, and maintains all shops and buildings constructed for its own purpose outside the limits of navy-yards. It is charged with the purchase, sale, and transfer of all land and buildings in connection therewith, except at navy-yards, and with the preservation of public property under its control. It determines upon and procures all the tools, stores, stationery, blank books, forms, material, means, and appliances of every kind required in its shops, including fuel and transportation. It superintends all work done under it, and estimates for and defrays from its own funds the cost necessary to carry out its duties as above defined.

BUREAU OF CONSTRUCTION AND REPAIR.

The duties of the Bureau of Construction and Repair comprise the responsibility for the structural strength and stability of all ships built for the Navy; all that relates to designing, building, fitting, and repairing the hulls of ships, turrets, spars, capstans, windlasses, steering gear, and ventilating apparatus, and, after consultation with the Bureau of Ordnance, and according to the requirements thereof as determined by that Bureau, the designing, construction, and installation of independent ammunition hoists, and the installation of the permanent fixtures of all other ammunition hoists and their appurtenances; placing and securing armor after the material, quality, and distribution of thickness have been determined by the Bureau of Ordnance; placing and securing on board ship, to the satisfaction of the Bureau of Ordnance, the permanent fixtures of the armament and its accessories as manufactured and supplied by that Bureau; installing the turret guns, turret mounts, and ammunition hoists, and such other mounts as require simultaneous structural work in connection with installation or removal; care and preservation of ships in ordinary, and requisitioning for or manufacturing all the equipage and supplies for ships prescribed by the authorized allowance lists. The Bureau of Construction and Repair also, after conference with the Bureau of Ordnance, designs the arrangements for centering the turrets, the character of the roller paths and their supports, and furnishes the Bureau every opportunity to inspect the installation on board of all permanent fixtures of the armament and accessories supplied by said Bureau. It has cognizance of all electric turret-turning machinery and of all electrically operated ammunition hoists (except turret hoists), the same to conform to the requirements of the Bureau of Ordnance as to power, speed, and control. It also has cognizance of stationary electrically operated fans or blowers for hull ventilation, boat cranes, deck winches, capstans, steering engines and telemotors therefor, and hand pumps not in the engine or fire rooms, and of electric launches and other boats supplied with electric motive power. It has charge of the docking of ships, and also designs the slips and the various buildings and shops, so far as their internal arrangements are concerned, where its work is executed, and is charged with the operating and cleaning of dry docks.

BUREAU OF STEAM ENGINEERING.

The duties of the Bureau of Steam Engineering comprise all that relates to the designing, building, fitting out, repairing, and engineering of the steam machinery used for the propulsion of naval vessels, and will also include steam pumps, steam heaters and connections, and the steam machinery necessary for actuating the apparatus by which turrets are turned.

MARINE CORPS.

The Commandant of the Marine Corps is responsible to the Secretary of the Navy for the general efficiency and discipline of the corps; makes such distribution of officers and men for duty at the several shore stations as shall appear to him to be most advantageous for the interests of the service; furnishes guards for vessels of the Navy, according to the authorized scale of allowance; under the direction of the Secretary of the Navy, issues orders for the movement of officers and troops, and such other orders and instructions for their guidance as may be necessary; and has charge and exercises general supervision and control of the recruiting service of the corps, and of the necessary expenses thereof, including the establishment of recruiting offices.

THE DEPARTMENT OF THE INTERIOR.

The Secretary of the Interior is charged with the supervision of public business relating to Patents for Inventions; Pensions and Bounty Lands; the Public Lands and Surveys; the Indians; Education; railroads; the Geological Survey; the Hot Springs Reservation, Arkansas; Yellowstone National Park, Wyoming, and the Yosemite, Sequoia, and General Grant parks, California; forest reservations; distribution of appropriations for agricultural and mechanical colleges in the States and Territories; the custody and distribution of certain public documents; and supervision of certain hospitals and eleemosynary institutions in the District of Columbia. He also exercises certain powers and duties in relation to the Territories of the United States.

COMMISSIONER OF PATENTS.

The Commissioner of Patents is charged with the administration of the patent laws, and supervises all matters relating to the issue of letters patent for new and useful inventions, discoveries, and improvements thereon, and also the registration of trade-marks, prints, and labels. He is by statute made the tribunal of last resort in the Patent Office, and has appellate jurisdiction in the trial of interference cases, of the patentability of inventions, and of registration of trade-marks. He is aided by an assistant Commissioner, chief clerk, three examiners in chief, an examiner of interferences, and thirty-nine principal examiners.

COMMISSIONER OF PENSIONS.

The Commissioner of Pensions supervises the examination and adjudication of all claims arising under laws passed by Congress granting bounty land or pension on account of service in the Army or Navy during the Revolutionary War and all subsequent wars in which the United States has been engaged. He is aided by two Deputy Commissioners and the chief clerk of the Bureau, each of whom has supervision over business arising in divisions of the Bureau assigned, under order of the Commissioner, to his immediate charge.

COMMISSIONER OF THE GENERAL LAND OFFICE.

The Commissioner of the General Land Office is charged with the survey, management, and sale of the public domain, and the issuing of titles therefor, whether derived from confirmations of grants made by former governments, by sales, donations, or grants for schools. railroads, military bounties, or public improvements. He is aided by an Assistant Commissioner and chief clerk.

COMMISSIONER OF EDUCATION.

The duties of the Commissioner of Education are to collect such statistics and facts as shall show the condition and progress of education in the several States and Territories, and to diffuse such information respecting the organization and management of schools and school systems and methods of teaching as shall aid the people of the United States in the establishment and maintenance of efficient school systems, and otherwise promote the cause of education throughout the country.

DIRECTOR OF THE GEOLOGICAL SURVEY.

The Director of the Geological Survey has charge of the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain, and the survey of forest reserves, including the preparation of topographic and geologic maps; also the measurement of streams and determination of the water supply of the United States, including the investigation of underground waters and artesian wells; and also the reclamation of arid lands, including the engineering operations to be carried on by the use of the reclamation fund created by act of June 17, 1902, from proceeds of sales of public lands.

THE BOARD ON GEOGRAPHIC NAMES.

That uniform usage in regard to geographic nomenclature and orthography shall obtain throughout the Executive Departments of the Government, and particularly upon maps and charts issued by the various Departments and Bureaus, this Board is constituted. To it shall be referred all unsettled questions concerning geographic names which arise in the Departments, and the decisions of the Board are to be accepted by the Departments as the standard authority in such matters.—Organized September 4, 1890.

THE NATIONAL ACADEMY OF SCIENCES.

(Incorporated by Act of Congress March 3, 1863.)

Section 3 of the act of incorporation provides: "That the National Academy of Sciences shall hold an annual meeting at such place in the United States as may be designated, and the academy shall, whenever called upon by any department of the Government, investigate, examine, experiment, and report upon any subject of science or art, the actual expense of such investigations, examinations, experiments, and reports to be paid from appropriations which may be made for the purpose; but the academy shall receive no compensation whatever for any services to the Government of the United States."

In accordance with this provision, the academy—which includes about one hundred members—has made many investigations and reports, at the request of the legislative and executive branches of the Government. The annual reports are published by Congress as House and Senate documents. Two meetings are held each year. The annual meeting is held in April, at Washington; the other in November, at such place as may be determined by the council.

THE CIVIL SERVICE COMMISSION.

The purpose of the civil-service act (approved January 16, 1883), as declared in its title, is "to regulate and improve the civil service of the United States." It provides for the appointment of three Commissioners, not more than two of whom shall be adherents of the same political party, and makes it the duty of the Commission to aid the President, as he may request, in preparing suitable rules for carrying the act into effect. The act requires that the rules shall provide, among other things, for open competitive examinations for testing the fitness of applicants for the public service, the filling of classified positions by selections from among those passing with highest grades, an apportionment of appointments in the Departments at Washington among the States and Territories, a period of probation before absolute appointment, and the prohibition of the use of official authority to coerce the political action of any person or body. The act also provides for investigations touching the enforcement of the rules promulgated, and forbids, under penalty of fine or imprisonment, or both, the solicitation by any person in the service of the United States of contributions to be used for political purposes from persons in such service, or the collection of such contributions by any person in a Government building.

THE CLASSIFIED SERVICE.

It is estimated that in 1902 there were 235,854 positions in the executive civil service, of which 20,931 were in the executive offices at Washington and 214,923 were outside. About 120,000 positions are classified subject to competitive examination under the civil service rules. Persons merely employed as laborers or workmen and persons nominated for confirmation by the Senate are exempted from the requirements of classification. Within these limits certain classes of positions are excepted from examination, among them being employees at postoffices not having free delivery, Indians, attorneys, pension examining surgeons, deputy collectors of internal revenue, office deputy marshals, and a few employees whose duties are of an important confidential or fiduciary nature.

EXAMINATIONS.

Examinations are held in every State and Territory twice a year. Full information respecting these examinations is to be found in a manual issued by the Commission in January and July of each year, for free distribution. The examinations range in scope from technical, professional, or scientific subjects to those based wholly upon the age, physical condition, experience, and character as a workman of the applicant, and in some cases do not require ability to read or write. To insure practical tests of fitness 654 different kinds of examinations were held during the year ended June 30, 1902, each of which involved different tests and more than half of which contained no educational tests, but consisted of certificates of employers or fellow workmen. During the fiscal year ended June 30, 1903, 86,787 persons were examined, 64,439 passed, and 26,343 were appointed.

THE FILLING OF VACANCIES.

A vacancy is filled from among the three persons of the sex called for standing highest on the appropriate register, the order being determined by the relative rating, except that the names of persons preferred under section 1754, Revised Statutes, come before all others. Until the rating of all papers of an examination is completed the identity of no applicant is known. A vacancy may also be filled by promotion, reduction, transfer, or reinstatement.

MILITARY PREFERENCE.

Persons discharged from the military or naval service by reason of disability resulting from wounds or sickness incurred in the line of duty and who receive a rating of at least 65 are certified first for appointment. All others are required to obtain a rating of 70 or more to become eligible. The rule barring reinstatement after a separation of one year does not apply to any person honorably discharged after service in the civil war or the war with Spain, or his widow, or an army nurse of either war.

THE PHILIPPINE CIVIL SERVICE.

Appointments to the insular civil service of the Philippines are made under an act passed by the Philippine Commission and rules promulgated by the Governor of the islands. The municipal service of Manila is also classified and subject to the provisions of the act and rules, which are similar to the United States act and rules. The United States Commission, under an Executive order, assists the Philippine Board by conducting examinations in the United States for the Philippine service and in all other practicable ways. These examinations are held only for positions for which competent natives cannot be found, the natives being preferred for appointment.

The United States rules permit the transfer of classified employees who have served for three years from the Philippine service to the Federal service.

THE CIVIL SERVICE IN PORTO RICO AND HAWAII.

The Federal positions in Porto Rico and Hawaii by act of Congress fall within the scope of the civil service act and are filled in the same ways as competitive positions in the United States. The competitive system does not extend to the insular and municipal positions of the islands.

UNCLASSIFIED LABORERS.

Appointments of unclassified laborers in the Departments at Washington under Executive order are required to be made in accordance with regulations to be approved by the heads of the several Departments and the Civil Service Commission. Such regulations have been adopted by several of the Departments, and the positions of laborers are being filled by the appointment of those applicants who are rated highest in age, physical condition, and industry and adaptability. The system is outside the civil service act and rules.

THE INTERSTATE COMMERCE COMMISSION.

This Commission, appointed under "An act to regulate commerce," approved February 4, 1887, has authority to inquire into the management of the business of all common carriers who are subject to the provisions of the act. These are all which are "engaged in the transportation of passengers or property wholly by railroad, or partly by railroad and partly by water when both are used, under a common control, management, or arrangement, for a continuous carriage or shipment, from one State or Territory of the United States or the District of Columbia to any other State or Territory of the United States or the District of Columbia, or from any place in the United States to an adjacent foreign country, or from any place in the United States through a foreign country to any other place in the United States, and also in the transportation in like manner of property shipped from any place in the United States to a foreign country and carried from such place to a port of transshipment, or shipped from a foreign country to any place in the United States and carried to such place from a port of entry either in the United States or an adjacent foreign country." It has jurisdiction to inquire into and report upon the reasonableness of rates on interstate traffic, to decide questions of unjust discrimination and of undue preference, to prescribe the publicity to be given to joint tariffs, and to in-

stitute and carry on proceedings for the enforcement of the provisions of the law. It has power to call for reports, to require the attendance of witnesses and the production of books and papers, to hear complaints of a violation of the act made against any such carrier, and to determine what reparation shall be made to a party wronged; to institute inquiries on its own motion or at the request of State railroad commissions, and to report thereon; and it is required to make an annual report, which shall be transmitted to Congress.

The act of March 2, 1893, known as the "Safety Appliance Act," provides that within specified periods railroad cars used in interstate commerce must be equipped with automatic couplers and standard height of drawbars for freight cars, and have grab irons or handholds on the ends and sides of each car.

A further provision of this act is that locomotive engines used in moving interstate traffic shall be fitted with a power driving wheel brake and appliances for operating the train brake system, and a sufficient number of cars in the train shall be equipped with power or train brakes. The act directs the Commission to lodge with the proper district attorneys information of such violations as may come to its knowledge. The Commission is authorized, from time to time, upon full hearing and for good cause, to extend the period within which any common carrier shall comply with the provisions of the statute. The act of March 2, 1903, amended this act so as to make its provisions apply to Territories and the District of Columbia, to all cases when couplers of whatever design are brought together, and to all locomotives, cars, and other equipment of any railroad engaged in interstate traffic, except logging cars and cars used upon street railways, and also to power or train brakes used in railway operation.

The act of March 3, 1901, "requiring common carriers engaged in interstate commerce to make reports of all accidents to the Interstate Commerce Commission," makes it the duty of such carrier monthly to report, under oath, all collisions and derailments of its trains and accidents to its passengers, and to its employees while on duty in its service, and to state the nature and causes thereof. The act prescribes that a fine shall be imposed against any such carrier failing to make the report so required.

THE DEPARTMENT OF COMMERCE AND LABOR.

The Secretary of Commerce and Labor is charged with the work of promoting the commerce of the United States, and its mining, manufacturing, shipping, fishery, transportation, and labor interests. His duties also comprise the investigation of the organization and management of corporations (excepting railroads) engaged in interstate commerce; the gathering and publication of information regarding labor interests and labor controversies in this and other countries; the administration of the Light House Service, and the aid and protection to shipping thereby; the taking of the census, and the collection and publication of statistical information connected therewith; the making of coast and geodetic surveys; the collecting of statistics relating to foreign and domestic commerce; the inspection of steamboats, and the enforcement of laws relating thereto for the protection of life and property; the supervision of the fisheries as administered by the Federal Government; the supervision and control of the Alaskan fur seal, salmon, and other fisheries; the jurisdiction over merchant vessels, their registry, licensing, measurement, entry, clearance, transfers, movement of their cargoes and passengers, and laws relating thereto, and to seamen of the United States; the supervision of the immigration of aliens, and the enforcement of the laws relating thereto, and to the exclusion of Chinese; the custody, construction, maintenance, and application of standards of weights and measurements; and the gathering and supplying of information regarding industries and markets for the fostering of manufacturing. He has power to call upon other Departments for statistical data obtained by them.

It is his further duty to make such special investigations and furnish such information to the President or Congress as may be required by them on the foregoing subject-matters and to make annual reports to Congress upon the work of said Department.

BUREAU OF LABOR.

The Bureau of Labor is charged with the duty of acquiring and diffus-

ing among the people of the United States useful information on subjects connected with labor in the most general and comprehensive sense of that word, and especially upon its relations to capital, the hours of labor, the earnings of laboring men and women, and the means of promoting their material, social, intellectual, and moral prosperity.

It is especially charged to investigate the causes of and facts relating to all controversies and disputes between employers and employees as they may occur, and which may happen to interfere with the welfare of the people of the several States.

LIGHT-HOUSE BOARD.

The Light-House Board has charge, under the superintendence of the Secretary of Commerce and Labor, of all administrative duties relating to the construction and maintenance of lighthouses, light vessels, light-house depots, beacons, fog signals, buoys, and their appendages, and has charge of all records and property appertaining to the Light-House Establishment.

BUREAU OF THE CENSUS.

The Bureau of the Census is charged with the duty of taking the periodical censuses of the United States and of collecting such special statistics as are required by Congress, including the collection in 1905 of the statistics of manufacturing establishments conducted under the factory system, and the collection annually of statistics of births and deaths in registration areas, statistics of the cotton production of the country as returned by the ginners, and (by transfer from the Bureau of Labor) statistics of cities of 30,000 or more inhabitants. Under the proclamation of the President dated September 30, 1902, the Bureau is charged with the compilation and tabulation of the returns of the Philippine census, taken as of March 2, 1903, under the direction of the Philippine Commission.

COAST AND GEODETIC SURVEY.

The Coast and Geodetic Survey is charged with the survey of the coasts of the United States and coasts under the jurisdiction thereof and the publication of charts covering said coasts. This includes base measure, triangulation, topography, and hydrography along said coasts; the survey of rivers to the head of tide-water or ship navigation; deep sea soundings, temperature, and current observations along said coasts and throughout the Gulf and Japan streams; magnetic observations and researches, and the publication of maps showing the variations of terrestrial magnetism; gravity research; determination of heights; the determination of geographic positions by astronomic observations for latitude, longitude, and azimuth, and by triangulation, to furnish reference points for State surveys. The results obtained are published in annual reports, with professional papers and discussions of results as appendices; charts upon various scales, including sailing charts, general charts of the coast, and harbor charts; tide tables issued annually, in advance; Coast Pilots, with sailing directions covering the navigable waters; Notices to Mariners, issued monthly and containing current information necessary for safe navigation; catalogues of charts and publications, and such other special publications as may be required to carry out the organic law governing the Survey.

BUREAU OF STATISTICS.

The Bureau of Statistics collects and publishes the statistics of our foreign commerce, embracing tables showing the imports and exports, respectively, by countries and customs districts; the transit trade inward and outward by countries and by customs districts; imported commodities warehoused, withdrawn from, and remaining in warehouse; the imports of merchandise entered for consumption, showing quantity, value, rates of duty, and amounts of duty collected on each article or class of articles; the inward and outward movement of tonnage in our foreign trade and the countries whence entered and for which cleared, distinguishing the nationalities of the foreign vessels. The Bureau also collects and publishes information in regard to the leading commercial movements in our internal commerce, among which are the commerce of the Great Lakes; the commercial movements in our internal commerce, among which are the commerce of the Great Lakes; the commercial movements at interior centers, at Atlantic, Gulf, and Pacific seaports; shipments of coal and coke; ocean freight rates,

etc. The Bureau also publishes daily and monthly the reports received from United States consuls and special reports on various subjects supplied by consuls on special request; also, annually, the declared exports from foreign countries to the United States furnished by consuls, and the annual report laid before Congress entitled "Commercial Relations of the United States."

STEAMBOAT-INSPECTION SERVICE.

The Steamboat-Inspection Service is charged with the duty of inspecting steam vessels, the licensing of the officers of vessels, and the administration of the laws relating to such vessels and their officers for the protection of life and property.

The Supervising Inspector-General and the supervising inspectors constitute a board that meets annually at Washington, and establishes regulations for carrying out the provisions of the steamboat-inspection laws.

BUREAU OF FISHERIES.

The work of the Bureau of Fisheries comprises (1) the propagation of useful food fishes, including lobsters, oysters, and other shellfish, and their distribution to suitable waters; (2) the inquiry into the causes of decrease of food fishes in the lakes, rivers, and coast waters of the United States, the study of the waters of the coast and interior in the interest of fish-culture, and the investigation of the fishing grounds of the Atlantic, Gulf, and Pacific coasts, with the view of determining their food resources and the development of the commercial fisheries; (3) the collection and compilation of the statistics of the fisheries and the study of their methods and relations.

BUREAU OF NAVIGATION.

The Bureau of Navigation is charged with general superintendence of the commercial marine and merchant seamen of the United States, except so far as supervision is lodged with other officers of the Government. It is specially charged with the decision of all questions relating to the issue of registers, enrollments, and licenses of vessels and the filing of those documents, with the supervision of laws relating to the admeasurement, letters, and numbers of vessels, and with the final decision of questions concerning the collection and refund of tonnage taxes. It is empowered to change the names of vessels, prepares annually a list of vessels of the United States, and reports annually to the Secretary of Commerce and Labor the operations of the laws relative to navigation.

BUREAU OF IMMIGRATION.

The Bureau of Immigration is charged with the administration of the laws relating to immigration and of the Chinese exclusion laws. It supervises all expenditures under the appropriations for "Expenses of regulating immigration" and the "Enforcement of the Chinese exclusion act." It causes alleged violations of the immigration, Chinese exclusion, and alien contract-labor laws to be investigated, and when prosecution is deemed advisable submits evidence for that purpose to the proper United States district attorney.

BUREAU OF STANDARDS.

The functions of the Bureau of Standards are as follows: The custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce,, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and properties of materials, when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere. The Bureau is authorized to exercise its functions for the Government of the United States, for any State or municipal government within the United States, or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuits requiring the use of standards or standard measuring instruments. For all comparisons, calibrations, tests, or investigations, except those performed for the Government of the United States or State governments, a reasonable fee will be charged.

THE INTERNATIONAL BUREAU OF THE AMERICAN REPUBLICS.

The International Bureau of the American Republics was established under the recommendation of the International American Conference in 1890 for the purpose of maintaining closer relations between the several Republics of the Western Hemisphere. It was reorganized by the International American Conference of 1901 and its scope widened by imposing many new and important duties. A prominent feature of the new arrangement was the foundation of the Columbus Memorial Library. The International Bureau corresponds, through the diplomatic representatives of the several Governments in Washington, with the executive departments of these governments, and is required to furnish such information as it possesses or can obtain to any of the Republics making requests. It is the custodian of the archives of the International American Conferences, and is especially charged with the performance of duties imposed upon it by these conferences. The International Bureau is sustained by contributions from the American Republics in proportion to their population. It publishes a monthly bulletin containing the latest official information respecting the resources, commerce, and general features of the American Republics, as well as maps and geographical sketches of these countries, which publications are considered public documents and as such are carried free in the mails of all the Republics.—Congressional Directory.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Any person may become a member of the association upon recommendation in writing by two members or fellows, and election by the council, or by the special committee of the council resident in Washington and empowered to pass upon applications whenever received.

The admission fee for members is five dollars, payable in advance. The annual dues for members and fellows are three dollars, payable in advance. The fiscal year of the association begins January 1st, and members and fellows are entitled to all publications issued, and to the privileges of all meetings held during the year for which they have paid dues.

Fellows are elected by the council from such of the members as are professionally engaged in science. The election of fellows is by ballot and a majority vote of the members of the council at a designated meeting of the council. On the election of any member as a fellow, an additional fee of two dollars shall be paid.

Any member or fellow who shall pay the sum of fifty dollars to the association, at any one time, shall become a life member, and as such shall be exempt from all further assessments, and shall be entitled to the proceedings of the association. All money thus received shall be invested as a permanent fund, the income of which, during the life of the member, shall form a part of the general fund of the association; but, after his death, shall be used only to assist in original research, unless otherwise directed by unanimous vote of the council.

Any person paying to the association the sum of one thousand dollars shall be classed as a patron, and shall be entitled to all the privileges of a member and to all its publications.

NATIONAL DEBTS OF THE WORLD.

CHAPTER XII.

POST OFFICE.

POSTAL INFORMATION.

Revised by the New York Post Office.

There are four classes of mail matter:

First-Class Matter—All written matter, such as letters, postal cards, "post cards" and all matter in writing, whether pen-written or typewritten, and all matter sealed from inspection, constitutes "First-class Matter," and is mailable at two cents an ounce, or fraction thereof. Letters, etc., may be sent to Canada, Cuba, the "Canal Zone" at Panama, Guam, Tutuila (Samoa), Shanghai (China), Mexico, Porto Rico, Hawaii, and the Philippines. Postal cards are one cent each. Local or "drop" letters are two cents an ounce or fraction thereof, when mailed at letter carrier offices, or at offices where Rural Delivery Service has been established, addressed to patrons thereof who may be served by rural carriers, and one cent for each ounce or fraction thereof at offices where free delivery by carrier is not established or at rural-delivery offices when addressed to patrons who cannot be served by the carriers.

Note—There is no "drop" rate on third or fourth-class matter: the postage on which is uniform whether addressed for local delivery or transmission in the mails.

The following articles are included in first-class matter: Assessment notices, autograph albums, blank books, with written entries, bank checks, blank forms filled out in writing, receipts, visiting cards bearing written name, communications entirely in print with the exception of name of sender, diplomas, drawings or plans containing written words, letters or figures, envelopes bearing written addresses, imitations or reproductions of hand or typewritten matter not mailed at the postoffice in a minimum number of twenty perfectly identical copies to separate addresses, legal and other blanks, old letters sent singly or in bulk, all sealed matter, stenographic or shorthand notes, and unsealed written communications.

Second-Class Matter—This division includes newspapers and other periodicals, which are issued as often as four times a year. The rate of postage on second-class matter when sent by the publisher thereof and from the office of publication to subscribers or as sample copies, or when sent from a news agency to actual subscribers or to other news agents for sale. is one cent a pound or fraction thereof, except when deposited in a letter carrier office for delivery by letter carriers, or mailed free within the county of publication. Publishers to obtain this rate must have their periodicals entered at their local post-office.

Third-Class Matter—Embraces all printed matter generally. The rate of postage is one cent for each two ounces or fractional part thereof sent to a single address, to be fully prepaid by ordinary postage stamps affixed thereto. The following named articles are among those subject to third-class rate of postage: Almanacs, printed architectural designs, blueprints, books (printed), bulbs, calendars printed on paper, cards printed on paper, Christmas cards, catalogues, check and receipt books (blank), circulars, press clippings, school copy books, printed engravings, samples of grain, imitation of hand or typewritten matter when mailed at the postoffice window in a minimum number of twenty identical copies separately addressed, printed labels, legal blanks, lithographs, maps, music books, photographs, plants, printed tags, roots, seeds, sheet music.

Fourth-Class Matter — Embraces merchandise, samples, and in general all articles not included in the first,

second or third class. The rate of postage is one cent an ounce or fraction thereof sent to a single address, to be prepaid by ordinary stamps affixed. The following are among articles included in fourth-class matter: Albums, photograph and autograph (blank), artificial flowers, billheads, blank books, blotters, botanical specimens, celluloid calendars, blank cards, celluloid, dried fruit, dried plants, electrotypes, geological specimens, maps printed on cloth, merchandise samples, merchandise sealed, metals, napkins, oil paintings, samples of cloth, samples of flour, soap wrappers, stationery.

Prohibited Articles.—Many articles are excluded from the foreign mails, the regulations being different in the case of each country. Inquiries should be made of the postmaster. Many articles are also excluded from domestic mails when they are liable to destroy, efface, or injure the contents of the mail bags or the persons of those engaged in the postal service. When in doubt consult your postmaster.

Withdrawal of Letters from the Mail.—It is not generally known that a letter can be withdrawn from the mail. For good and sufficient reasons and satisfactory identification a postmaster may telegraph to a postmaster in another city, asking him to withdraw the letter, a description of which is telegraphed. Special care is then given in assorting letters, and when the letter is found it is returned to the postmaster of the city where it was mailed, who delivers it to the person mailing it on presentation of proper proof of ownership. All expenses must be borne by the person withdrawing a letter from the mail. A deposit of $5 must be left with the postmaster when the application is made. It is also possible to withdraw a for-

POSTAL SERVICE

Domestic.	Number of letters. Postage prepaid. 1	Not prepaid. 2	Number of post cards. 3	Printed matter. 4	Commercial papers. 5
Argentine Republic	159,385,020	See Col. 1	3,588,504	152,515,894	See Col. 4
Australasia	211,254,801	See Col. 1	2,705,126	43,064,753	38,227,430
Austria	440,675,600	4,180 400	264,989,700	55 221,700	....
Belgium	101,644,321	427,856	59,804,004	257,568,220	1,797,198
Bolivia	787,467	4,226	24,170	340,629	10,900
British India	222,394,627	28,462,364	227,062,615	59,367,511	See Col. 4
Bulgaria	3,739,812	186,854	6,042,720	8,955,534	90,304
Chili	24,768,283	448 609	462,694	948,864	4,964
Costa Rica	1,820,831	....	69,726	1,328,214	366,104
Cuba	6,489,631	18,296	1,916,326	902,500	1,050,300
Denmark	74,223,431	99,418	4,764,940	4,354,662	....
Dominican Republic	781,080	65,883	14,475	459,867	....
Egypt	12,060,000	300,000	590,000	9,400,000	80,000
France	820,708,041	3,016,145	64,442,350	1,130,475,202	43,811,675
Germany	1,557,679,710	30,259,540	1,062,679,460	957,361,710	8,460,270
Great Britain	2,579,500,000	See Col. 1	488,900,000	175,400,000	809,800,000
Hungary	118,121,668	1,446,906	85,193,768	36,897,440	....
Italy	198,064,428	4,670,035	77,454,468	385,375,075	9,341,668
Japan	205,076,343	See Col. 1	483,021,736	156,514,420	3,286,535
Mexico	37,963,823	743,508	1,087,300	70,766,739	See Col. 4
Netherlands	80,455,526	540,113	54,492,724	164,793,766	....
Norway	30,695,300	202,600	4,199,700	4,321,200	57,300
Portugal	22,561,727	83,762	9,543,240	24,145,500	477,787
Roumania	11,751,558	1,121,401	14,057,882	24,908,318	207,451
Russia	300,822,581	5,476,878	97,701,412	80,444,160	4,190,274
Spain	122,590,854	....	13,681,624	194,884,182	99,985
Sweden	76,920,350	296,513	37,739,367	11,363,997	194,078
Switzerland	92,583,216	330,260	48,631,989	41,226,016	....
United States of America	3,732,031,938	139,151,837	740,087,805	3,306,582,333	....
Uruguay	3,350,544	31,189	167,407	14,442,140	362,042

* Figures cover both

eign letter from the mail, and in that case the deposit is $25. Any unexpended balance is, of course, returned.

FEES FOR MONEY ORDERS.

Payable in the United States (which includes Guam, Hawaii, Porto Rico and Tutuila, Samoa); also for Orders payable in Canada, Cuba, Newfoundland. the United States Postal Agency at Shanghai (China), the Philippine Islands, Barbados, Grenada, Saint Lucia, and St. Vincent.

For Orders for sums not exceeding $2.50, 3 cents.
Over $2.50 and not exceeding $5.00, 5 cents.
Over $5.00 and not exceeding $10.00, 8 cents.
Over $10.00 and not exceeding $20.00, 10 cents.
Over $20.00 and not exceeding $30.00, 12 cents.
Over $30.00 and not exceeding $40.00, 15 cents.
Over $40.00 and not exceeding $50.00, 18 cents.
Over $50.00 and not exceeding $60.00, 20 cents.
Over $60.00 and not exceeding $75.00, 25 cents.
Over $75.00 and not exceeding $100.00, 30 cents.

NOTE.—The maximum amount for which a single Money Order may be issued is $100. When a larger sum is to be sent additional Orders must be obtained. Any number of Orders may be drawn on any Money Order office; but, if Orders are drawn in excess of $200 on any one day upon an office of the 4th class, notice of the fact by letter (or Form 6037) is to be promptly sent the Department by the issuing Postmaster so that provision may be made for payment.

OF THE WORLD.

Samples of merchandise. 6	Total of preceding columns, adding free matter, etc. 7	Ordinary Packages. 8	Money orders. Number. 9	Money orders. Value in Dollars. 10	Number of Letter Boxes. 11	Number of Employees. 12
See Col. 4	319,119,054	....	....	2,130,321	2,519	6,163
See Col. 5	333,558,972	1,099,384	2,165,016	16,761,631	7,878	15,492
14,449,000	836,380,800	25,751,600	25,833,578	237,803,784	30,996	58,888*
4,782,544	453,433,761	3,412,268	1,525,197	36,898,771	8,500	7,371
1,623	1,231,264	18,373	....	....	457	921
See Col. 4	554,156,454	1,621,646	13,640,140	86,551,999	51,347	60,174*
50,830	22,226,790	110,371	225,243	4,207,871	2,412	1,781*
58,404	58,805,378	584,986	329,282	3,598,348	1,130	2,175
6,736	3,844,132	63,482	....	....	162	215
121,360	11,893,177	10,624	64,710	2,076,036	1,111	767
293,720	83,761,851	2,685,320	2,616,660	17,938,179	10,531	7,011
8,139	1,329,444	....	....	....	112	132
110,000	25,150,000	200,500	503,500	12,584,000	1,317	1,590
51,024,069	2,113,656,692	44,638,979	43,473,736	304,135,418	68,156	81,659*
46,997,370	3,781,632,920	183,994,828	159,117,020	2,390,185,643	126,481	241,967*
See Col. 5	4,053,600,000	87,014,292	104,201,954	357,210,065	58,873	183,595*
2,170,864	290,196,722	9,316,406	15,857,701	157,812,182	11,237	22,582*
10,021,951	747,040,295	9,243,969	15,295,051	200,800,478	23,760	30,925*
2,781,546	882,765,664	9,519,910	9,203,258	47,752,424	51,058	57,965*
664,662	120,887,017	251,556	920,824	41,811,849	1,142	10,477
1,802,204	311,406,621	4,537,142	4,159,398	24,616,865	4,583	8,364
164,400	43,830,800	334,500	289,722	6,050,873	4,070	3,673
697,515	60,208,773	253,806	296,410	4,082,509	6,097	6,525*
369,845	43,643,104	133,514	860,694	5,951,183	4,903	6,886*
3,510,005	591,932,272	2,495,802	16,916,041	377,446,238	21,065	57,962*
915,180	350,692,763	....	....	....	8,979	5,293
623,510	132,704,875	983,668	3,078,112	24,764,948	5,648	8,246
385,545	198,682,821	18,045,172	6,472,827	133,719,746	10,349	12,324
84,798,683	8,002,652,596	....	40,474,327	325,925,666	129,335	239,652
32,116	18,801,025	9,800	38,174	4,204,775	1,016	1,582

post office and telegraph officials.

POSTAL SERVICE OF THE WORLD.—Continued.

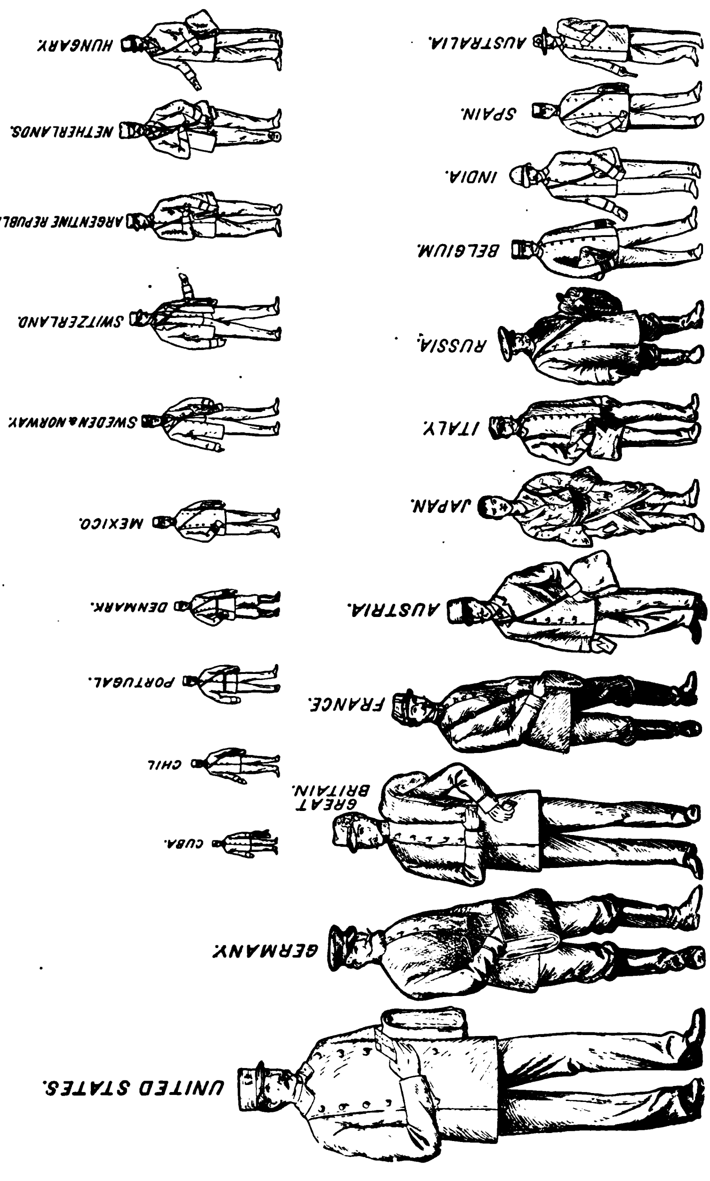
Foreign postal matter sent out.	Number of letters.		Number of post cards.		Printed matter. 5	Commercial papers. 6	Samples of merchandise. 7	Total, including free matter. 8	Money orders.	
	Postage prepaid. 1	Not prepaid. 2	Single 3	With reply paid. 4					Number 9	Value in dollars. 10
Argentine Republic	4,686,577	See col. 1	171,025	See col. 3	2,282,204	See col. 5	See col. 5	7,144,691	....	89,161
Australasia	15,502,463	See col. 1	See col. 1	See col. 1	14,976,730	4,214,096	See col. 6	35,106,910	365,831	5,111,983
Austria	124,528,390	1,401,490	53,982,640	868,110	39,091,530	310,240	6,537,460	229,262,820	3,576,703	50,816,968
Belgium	25,430,678	196,703	8,843,185	50,479	22,204,728	290,290	1,488,422	58,595,551	502,297	5,322,398
Bolivia	154,208	1,140	7,487	91	60,591	1,690	366	228,498	....	....
Bulgaria	909,972	62,272	522,438	3,184	405,466	5,074	32,842	1,990,302	68,851	2,181,104
Chili	1,584,259	22,251	39,629	305	1,705,864	240	5,675	3,454,317	4,556	32,134
Costa Rica	109,040	....	11,381	....	118,870	....	1,490	244,249	....	....
Cuba	1,616,729	9,128	178,326	....	96,300	55,030	21,644	1,999,093	32,693	678,113
Denmark	7,285,924	41,010	1,812,480	23,088	1,640,760	35,996	174,444	11,013,702	195,616	1,947,634
Dominican Republic	57,920	3,813	3,953	See col. 3	10,120	....	425	76,231	....	....
Egypt	3,015,000	40,000	420,000	5,000	1,500,000	15,000	100,000	5,100,000	112,000	1,976,000
France	71,921,364	487,500	3,065,808	113,143	76,814,171	837,294	5,647,705	158,886,985	1,875,680	18,855,293
Germany	130,554,980	1,516,550	36,489,670	357,330	66,254,950	728,200	7,456,740	243,937,970	2,908,116	28,256,389
Great Britain	....	....	....	....	....	....	....	....	686,740	9,523.196
Hungary	24,406,854	983,788	14,238,952	33,384	5,024,266	3,432	648,648	46,745,944	3,540,613	45,231,893
India, British	6,021,981	See col. 1	See col. 1	See col. 1	2,920,279	See col. 5	See col. 5	8,942,260	114,982	1,931,883
Italy	26,558,615	1,789,318	3,990,808	112,938	7,953,757	199,788	1,346,238	42,032,857	221,277	2,352,639
Japan	3,460,633	26,169	959,840	4,798	2,125,612	24,667	101,374	6,776,575	8,381	126,380
Mexico	7,081,946	40,004	139,730	4,649	5,769,238	See col. 5	205,324	13,316,256	14,958	479,196
Netherlands	13,620,907	194,430	5,303,677	64,922	8,673,815	118,834	1,481,757	29,491,093	321,427	2,569,450
Norway	4,446,884	69,293	767,546	2,821	1,014,441	34,047	64,935	6,425,707	158,936	1,243,609
Portugal	3,701,776	142,845	622,149	1,357	3,676,176	70,652	76,336	8,296,841	16,577	113,070
Roumania	4,011,212	232,580	2,530,331	20,376	1,474,714	103,177	456,535	8,882,806	359,801	3,203,887
Russia	22,140,299	1,180,710	8,678,178	422,382	7,795,650	384,604	1,326,859	41,928,691	14,535	239,091
Spain	19,107,072	207,384	2,287,278	7,152	17,596,768	62,390	475,542	39,751,296	....	....
Sweden	6,528,950	393,900	1,465,777	3,055	1,337,232	46,345	77,805	9,891,050	202,783	1,805,450
Switzerland	20,789,204	416,989	19,981,009	60,685	10,800,851	163,538	1,489,185	53,823,555	1,065,976	8,228,494
United States of America	79,200,022	1,568,892	5,737,464	56,604	97,497,965	343,814	1,444,790	186,370,315	1,311,111	23,600,491
Uruguay	971,364	19,001	126,595	....	3,918,436	1,064	6,690	5,045,258	2,606	49,898

POSTAL SERVICE OF THE WORLD.—Continued.

Foreign postal matter received.	Number of letters.		Number of post cards.		Printed matter. 5	Commercial papers. 6	Samples of merchandise. 7	Total, including free matter. 8	Money orders.	
	Postage prepaid. 1	Not prepaid. 2	Single. 3	With reply paid. 4					Number. 9	Value in dollars. 10
Argentine Republic	13,511,247	See col. 1	36,006	See col. 3	10,209,011	See col. 5	See col. 5	23,762,298	....	....
Australasia	17,577,805	See col. 1	See col. 1	See col. 1	16,657,084	2,233,228	See col. 6	38,015,821	396,877	5,313,869
Austria	119,405,590	1,101,650	60,874,670	667,570	24,252,060	192,520	5,442,990	214,334,340	5,009,384	61,947,412
Belgium	20,337,668	482,196	7,838,636	20,644	14,464,320	284,856	1,538,784	45,062,212	441,953	5,277,914
Bolivia	193,594	2,234	13,509	101	259,909	37,037	6,759	515,141	....	....
British India	6,865,258	See col. 1	See col. 1	See col. 1	9,281,797	See col. 5	See col. 5	16,147,055	263,270	4,660.721
Bulgaria	1,345,504	67,662	724,742	10,572	1,276,084	15,642	76,078	3,555,878	41,351	402.397
Chili	2,001,052	28,046	98,145	5,451	4,266,586	1,527	67,635	6,539,467	994	33,212
Costa Rica	197,862	....	11,298	....	247,148	....	3,821	460,583	....	....
Cuba	3,537,420	1,896	114,121	....	2,185,400	1,826,361	635,836	8,316,692	9,019	240,161
Denmark	6,693,308	42,948	1,872,420	7,080	2,361,356	56,144	423,352	11,456,608	246,067	1,724,828
Dominican Republic	106,230	7,319	5,377	See col. 3	104,087	....	2,838	225,851	....	....
Egypt	3,315,000	70,000	356,000	4,000	3,400,000	20,000	80,000	7,250,000	13,900	282,100
France	66,809,935	483,611	2,836,641	122,179	40,491,570	641,451	2,870,703	114,256,090	1,714,945	28,290,545
Germany	123,450,700	1,354,880	34,961,840	245,410	59,234,080	682,500	8,003,450	228,447,000	3,916,215	39,061,374
Great Britain	Included i	n figures o	n Int. serv	ice.	....	....	....	....	2,910,306	27,911,268
Hungary	27,189,624	338,286	15,545,478	40,222	8,046,922	3,198	820,804	53,346,932	2,591,239	31,824,739
Italy	25,941,120	1,355,326	3,436,230	125,500	8,122,360	183,540	1,395,615	40,662,995	1,008,874	11,780,269
Japan	4,011,770	41,437	849,004	3,709	1,840,648	20,469	153,111	7,010,517	51,870	1,963,742
Mexico	5,511,488	107,163	340,542	6,096	25,465,222	See col. 5	438,672	31,953,199	9,587	450,699
Netherlands	16,392,106	311,690	5,979,227	45,497	10,427,707	109,984	1,096,126	34,390,463	373,467	3,655,379
Norway	6,794,500	77,300	1,059,400	3,500	2,567,000	24,300	294,500	10,827,500	113,039	1,856,273
Portugal	3,956,190	41,185	422,466	2,028	2,642,498	92,762	156,305	7,330,100	19,319	429,118
Roumania	5,180,241	285,700	2,195,910	16,828	3,002,292	67,778	327,016	11,098,392	61,247	701,245
Russia	26,815,766	473,426	9,432,729	325,846	15,125,101	389,037	1,755,096	54,317,001	72,010	1,763,130
Spain	12,431,394	138,126	1,941,136	10,746	23,263,500	68,862	482,322	38,350,414	....	....
Sweden	11,004,586	125,896	1,802,953	2,756	3,675,479	28,899	454,168	17,134,842	201,186	3,311,638
Switzerland	22,742,759	966,524	12,506,689	49,397	15,367,755	154,986	1,384,721	53,257,968	635,454	5,833,775
United States of America	67,537,159	3,445,889	4,523,430	45,583	48,534,193	124,414	1,213,343	125,933,172	307,679	6,032,881
Uruguay	1,389,997	50,372	140,728	....	4,266,552	454,644	49,323	6,352,746	....	....

NOTE.—This table does not include transit matter and matter sent out.

—*From Reports of the Universal International Postal Union.*



COMPARISON OF THE POSTAL SERVICE OF THE WORLD.

SUGGESTION TO THE PUBLIC ON POSTAL SUBJECTS.

How to Direct and Mail Letters.—Mail matter should be addressed legibly and completely, giving the name of the postoffice, county and State, and the postoffice box of the person addressed, if he has one; if to a city having a free delivery, the street and number should be added. To secure return to the sender in case of misdirection or insufficient payment of postage, his name should be written or printed upon the upper left-hand corner of all mail matter; it will then be returned to the sender, if not called for at its destination, without going to the Dead Letter Office, and, if a letter, it will be returned free.

Dispatch is hastened by mailing early, especially when large numbers of letters, newspapers or circulars are mailed at once.

When a number of letters or circulars are mailed together, addressed to the same destination, it is well to tie them in bundles with the addresses facing the same side. On letters for places in foreign countries, especially Canada and England, in which many postoffices have the same name as offices in the United States, the name of the country as well as postoffice should be given in full. Letters addressed, for instance, merely to "London," without adding "England," are frequently sent to London, Canada, and *vice versa*, thereby causing delay, and often serious loss. Letters addressed to Burlington, N. S. (Nova Scotia), often go to Burlington, New York, on account of the resemblance between S and Y when carelessly written.

Avoid Thin Envelopes.—Thin envelopes, or those made of weak or poor, unsubtantial paper, should not be used, especially for large packages. Being often handled, and subjected to pressure and friction in the mail bags, such envelopes are frequently torn open or burst, without fault of those who handle them. It is best to use Stamped Envelopes wherever it is convenient and practicable to do so.

Registered Valuable Matter.—All valuable matter should be registered. Registry fee is eight cents, which, with full postage, must be prepaid, and name and address of sender must be given on the outside of envelope or wrapper. Money should be sent by a money order or registered letter; otherwise it is liable to be lost.

The Convenience of Letter Boxes.—Patrons in cities where letter carriers are employed are advised to provide letter boxes at places or private residences, thereby saving much delay in the delivery of mail matter.

Affix Stamps Firmly.—Postage stamps should be placed upon the upper right-hand corner of the address side of all the mail matter, care being taken that they are securely affixed.

General Suggestions.—A subscriber to a newspaper or periodical who changes his residence and postoffice should at once notify the publisher, and have the publication sent to his new address.

Publishers and news agents mailing second-class matter in quantities, will facilitate its distribution, and often hasten its dispatch, by separating such matter by States and Territories and the larger cities.

Hotel Matter.—That is, matter addressed for delivery at hotels, should be returned to the postoffice as soon as it is evident that it will not be claimed. Proprietors of hotels, officers of clubs and boards of trade, or exchanges, should not hold unclaimed letters longer than ten days, except at the request of the person addressed, and should re-direct them for forwarding, if the present address is known; otherwise they should be returned to the postoffice.

Letters addressed to persons temporarily sojourning in a city where the Free Delivery System is in operation should be marked "Transient" or "General Delivery," if not addressed to a street and number or some other designated place of delivery.—Post Office Guide.

THE UNITED STATES POST OFFICE.

POSTAL REVENUE IN DETAIL FOR YEAR ENDING JUNE 30, 1903.

The postal revenue from all sources was as follows:

Sales of stamps, stamped envelopes, newspaper wrappers, and postal cards	$123,511,549.70
Second-class postage (pound rates) paid in money	5,095,379.62
Box rents	3,065,675.06
Revenue from money-order business	2,239,908.24
Letter postage paid in money, principally balances due from foreign postal administrations	$186,426.83
Miscellaneous receipts	58,105.94
Fines and penalties	46,476.04
Receipts from unclaimed dead letters	20,921.81
Total receipts	$134,224,443.24

EXPENDITURES IN DETAIL.

The expenditures of the postal service for the year are shown, by items, in the following statement:

Transportation of mails on railroads	$36,195,116.18
Compensation to postmasters	21,631,724.04
Free-delivery service	19,337,986.00
Compensation of clerks in post-offices	17,140,651.11
Railway mail service	11,228,845.75
Rural free delivery	8,011,635.48
Transportation of the mails on star routes	6,561,819.35
Railway post-office car service	5,033,464.22
Transportation of foreign mails	2,427,160.36
Rent, light, and fuel for first, second, and third-class post-offices	2,360,968.91
Compensation to assistant postmasters at first and second-class post-offices	1,622,730.12
Mail-messenger service	1,091,259.98
Transportation of mails—regulation, screen, or other wagon service	828,707.93
Manufacture of stamped envelopes	724,787.37
Transportation of mails on steamboats	634,957.08
Mail depredations and post-office inspectors	543,976.55
Transportation of the mails, electric and cable cars	440,420.41
Manufacture of postage stamps	336,437.10
Mail bags and catchers	274,219.71
Miscellaneous items at first and second class offices	256,620.98
Canceling machines	195,803.46
Manufacture of postal cards	$188,865.98
Balance due foreign countries	153,539.82
Registered package, tag, official, and dead-letter envelopes	150,754.82
Pneumatic-tube service	142,867.04
Payment of money orders more than one year old	141,390.68
Wrapping twine	132,635.47
Transportation of the mails, special facilities	122,347.18
Blanks, blank books, etc., for money-order service	112,179.20
Stationery for postal service	68,760.66
Postal laws and regulations	51,826.48
Printing facing slips, slide labels, etc	46,862.47
Postmarking and rating stamps	42,572.95
Mail locks and keys	42,534.33
Wrapping paper	39,835.04
	138,316,264.21
Expenditures under 24 smaller items of appropriation	175,202.06
Total expenditures for the year	138,491,466.27
Add expenditures during the year on account of previous years	293,021.70
Total expenditures during the year	138,784,487.97
Excess of expenditures over receipts	4,560,044.73
Receipts	$134,224,443.24

MONEY ORDER BUSINESS.

Number of money-order offices in operation, 1902	31,680
Number of money-order offices in operation, 1903	34,547
Number of domestic money orders issued, 1903	45,941,681
Amount of domestic orders issued, 1903	$353,627,648.03
Amount of orders paid and repaid, 1903	353,173,320.52
Excess of receipts over expenses, paid from the proceeds, 1903	1,904,887.63

NUMBER OF POST OFFICES, EXTENT OF POST-ROUTES, AND REVENUE AND EXPENDITURES OF THE POST OFFICE DEPARTMENT, INCLUDING AMOUNTS PAID FOR TRANSPORTATION OF THE MAIL, 1877, 1887, 1897, AND 1903.

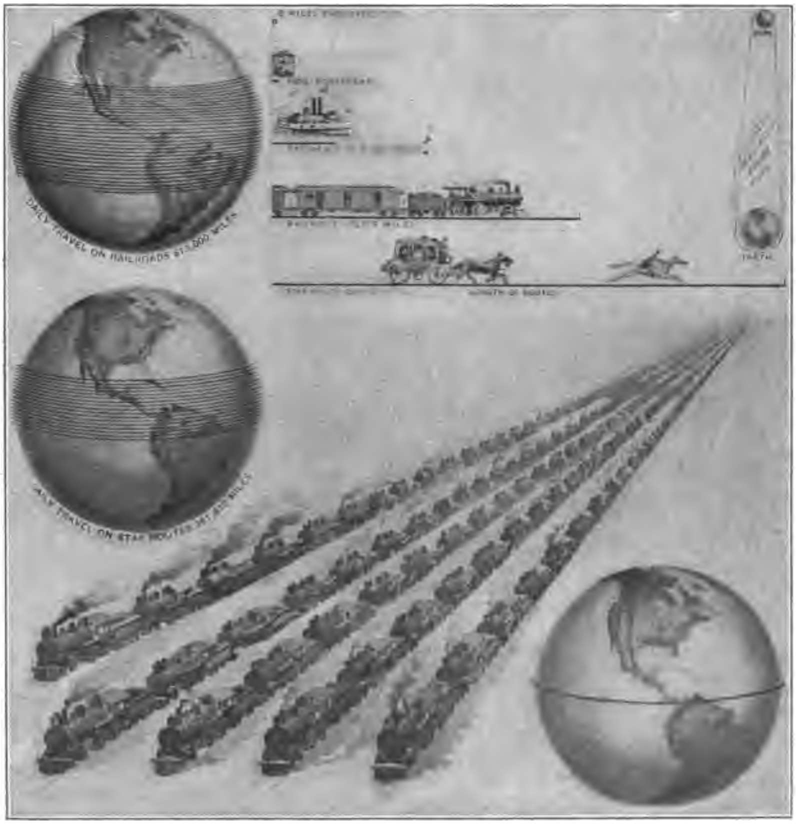
Year ending June 30—	Post-offices.	Extent of post-routes.	Revenue of the Department.	Expended for transportation of— Domestic mail.	Expended for transportation of— Foreign mail.	Total expenditure of the Department.
	Number.	Miles.	Dollars.	Dollars.	Dollars.	Dollars.
1877	37,345	292,820	27,531,585	18,774,235	448,896	33,486,322
1887	55,157	373,142	48,837,610	27,892,646	402,523	53,006,194
1897	71,022	470,032	82,665,463	48,028,094	1,890,099	94,077,242
1903	74,169	506,268	134,224,443	62,606,015	2,580,700	138,784,488

—From the Annual Reports of the Postmaster-General.

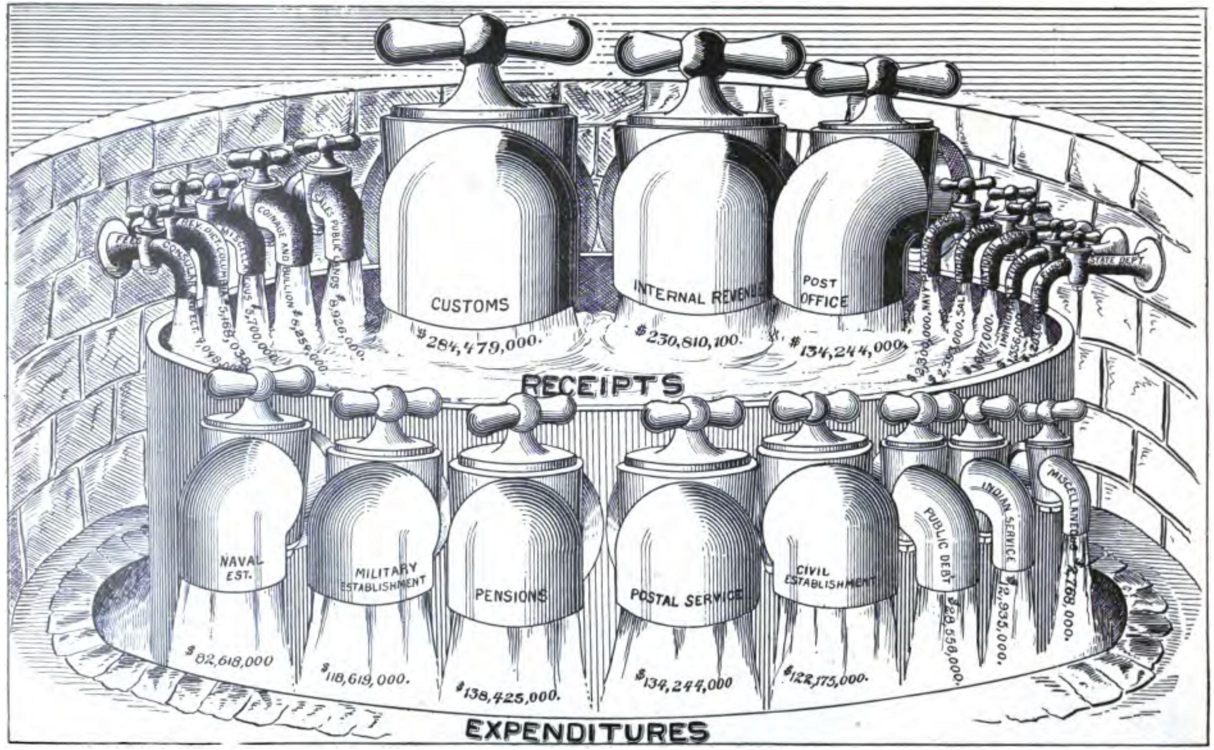
RAILROAD MILEAGE UPON WHICH MAIL WAS CARRIED, ANNUAL COST AND AVERAGE COST PER MILE OF RAILROAD MAIL TRANSPORTATION, AND EXPENDITURE FOR RAILWAY MAIL SERVICE EMPLOYEES.

Year ending June 30.	Total railroads in operation in United States Dec. 31.	Railroads upon which mail was carried.	Annual transportation of mail by railroads.	Railroad mail transportation.		Railway Mail Service.	
				Annual cost of.	Average annual cost per mile.	Number of employees.	Annual expenditure.
	Miles.	Miles.	Miles.	Dollars.	Dollars.		Dollars.
1877...	79,082	74,546	85,358,710	8,053,936	.1060	2,500	2,484,846
1887...	149,214	130,949	169,689,866	18,056,272	.1064	4,851	4,694,562
1897...	184,591	173,475	273,190,356	33,876,521	.1240	7,602	7,782,547
1903...	....	192,852	333,491,684	41,886,848	.1256	10,418	11,250,042

—Prepared in the Office of the Postmaster-General.



GRAPHICAL REPRESENTATION OF SOME INTERESTING STATISTICS OF THE U. S. POSTAL SERVICE, BASED ON FIGURES FOR 1901.



RECEIPTS AND EXPENDITURES OF THE FEDERAL GOVERNMENT FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

CHAPTER XIII.

INTERNATIONAL INSTITUTIONS AND BUREAUS.

THE NOBEL PRIZES.

The Nobel Foundation is based upon the last will and testament of Dr. Alfred Bernhard Nobel, engineer and inventor of dynamite, dated November 27, 1895, the stipulations of which, respecting this fund, are as follows:

"The rest of my fortune, that is, the capital realized by my executors, is to constitute a fund, the interest of which is to be distributed annually as a prize to those who have in the course of the previous year rendered the greatest services to humanity. The amount is to be divided into five equal parts, one of which is to be awarded to the person who has made the most important discovery in the domain of physical science; another part to the one who has made the most valuable discovery in chemistry or brought about the greatest improvement; the third to the author of the most important discovery in the field of physiology or medicine; the fourth to the one who has produced the most remarkable literary work of an idealist tendency, and finally the fifth to the person who has done the best or the most in the cause of the fraternity of nations, for the suppression or the reduction of standing armies as well as for the formation and propagation of peace congresses. The prizes will be awarded for physics and chemistry by the Swedish Academy of Sciences; for works in physiology or medicine by the Caroline Institute of Stockholm; for literature by the Stockholm Academy, and finally for the service in the cause of peace by a Committee of five members of the Norwegian Storthing. It is my express desire that the benefits of the foundation are to be open to all nationalities and sexes and that the prize be awarded to the one most worthy, whether Scandinavian or not."

Each prize will amount to about $40,000, and the corporation will designate a "Comité Nobel" composed of three or five members for each section, with headquarters at Christiania, Norway.

The Swedish Academy of Sciences, Stockholm, awards the Physics and Chemistry Prizes; the Caroline Medical Institute, Stockholm, awards the Prize for Physiology or Medicine; the Swedish Academy in Stockholm awards the Literature Prize; and the Peace Prize is awarded by a Committee of five persons elected by the Norwegian Storthing. No consideration is paid to the nationality of the candidates, but it is essential that every candidate shall be proposed in writing by some qualified representative of science, literature, etc., in the chief countries of the civilized world, such proposals to reach the Committee before the first of February in each year, the awards being made on the following 10th of December. Nobel Institutes are to be established in each of the five departments, to carry out scientific investigations as to the value of the discoveries and improvements, and to promote the other objects of the Foundation.

The first distribution of prizes took place in 1901, the awards being: Peace, MM. Dunant and Passy; Medicine, Dr. Behring, of Marburg; Chemistry, Prof. J. H. van 't Hoff, Berlin; Physics, Prof. Röntgen; and Literature, M. Sully Prudhomme.

The 1902 Prizes were awarded as follows: Literature, Prof. Theodor Mommsen, of Berlin; Peace, MM. Ducommun and Gobat (Switzerland); Medicine, Major Ronald Ross, of the School of Tropical Medicine, Liverpool; Chemistry, Prof. Emil Fischer, of Berlin; Physics, divided between Profs. Lorentz and Zeemann, of Holland.

The 1903 Prizes were awarded thus: Peace, Mr. W. R. Cromer, M. P.; Literature, M. Björnson; Medicine, Prof. Finsen, of Copenhagen; Physics, Prof. Becquerel, of Paris, and Mme. Curié, of Paris; Chemistry, Prof. Arrhenius, of Stockholm.

All information can be obtained from Nobelstiftelsen, Stockholm, or as to the Peace Prize, from the Comité Nobel Norvégien, Victoria Terrasse, 7, III., Christiania.

THE ANTHONY POLLOK PRIZE.

No doubt many inventors are wondering what disposition has been made of the Anthony Pollok Prize. Communications which have been received by the editor from Paris state that, owing to the unsatisfactory results of the former competition, the founders of the prize were undecided as to what should be done. Before taking any steps it was thought advisable to make an investigation. The Intermaritime Association in Paris sent out letters to the leading maritime associations, chambers of commerce and boards of trade of the principal maritime cities of the world, asking for advice as to the best methods to be pursued in order to obtain more satisfactory results in a possible future competition. Many replies were received and a large number of suggestions made.

A report containing the various recommendations and suggested changes was submitted by the Intermaritime Association but a short time ago. The founders of the Anthony Pollok Prize intend shortly to pass upon the report and adopt resolutions for the final disposition of the prize.

INTERNATIONAL INSTITUTIONS AND BUREAUS.

Feeling that a large majority of our readers may not have access to the sources of information from which the following data are drawn, we take the liberty of presenting them with the most interesting facts concerning the origin and composition of some of the International Institutions and Bureaus in which the United States as a power, and we as a people, are interested.

I. THE PERMANENT COURT OF ARBITRATION.

This court, more popularly known as The Hague Tribunal, was constituted by virtue of the convention for the pacific regulation of international questions, concluded at The Hague, July 29, 1899. (Office, Prinsegracht 71, The Hague.)

Administrative Council.—President: The Minister for Foreign Affairs for Holland. Members: The diplomatic representatives of all the signatory powers accredited to The Hague.

Members of the Permanent Court of Arbitration.—Since the individuals themselves are constantly changing by ill health or death, we shall content ourselves by giving the signatory powers alone, letting it suffice to say that these powers appoint their most distinguished men, preferably lawyers, to the position. They are: Austria-Hungary, Belgium, Bulgaria, Denmark, France, Germany, Great Britain, Greece, Holland, Italy, Japan, Luxemburg, Mexico, Portugal, Roumania, Russia, Servia, Spain, Sweden and Norway, Switzerland, and the United States.

II. THE UNIVERSAL INTERNATIONAL POSTAL UNION.

The Universal Postal Union, founded by the Congress at Bern in 1874, constitutes a single territory for the reciprocal exchange of correspondence between the Postal Departments of the nations present at the Congress. Its scope has been further enlarged and developed by succeeding conventions and conferences at Bern (1876), Paris (1880), Lisbon (1885), Vienna (1891), and Washington (1897); today it comprises all the states and all the colonies having organized postal systems, including nearly the whole world.

To the chief convention of the Union, regulating the exchange of letters, postal cards, printed matter, official papers and samples have from time to time been added, special arrangements concluded between the most of the members having for their object the international interchange of letters and packages possessing a declared value, postal money orders, postal packages and collections, together with a passport service and a department for the subscription to journals and other publications.

A central office, created by the Congress at Bern, has its seat in that city and is known under the name of The International Bureau of the Universal Postal Union. It performs its labors under the supervision of the Swiss Postoffice Department. The ordinary annual expenses of this office were first fixed at 75,000 francs, later advanced to 100,000 and finally increased to 125,000 francs, by the Congress of Vi-

enna. The funds are provisionally advanced by the Swiss Government, which is reimbursed by all the contracting parties in proportion to their importance.

This bureau is charged with collecting, co-ordinating, publishing and distributing information of whatever nature appertaining to international postal affairs. Its duties are also to issue, upon the demand of any one of the members of the Union, a note upon questions in litigation, to examine into the demands for the modification of the acts of the Congress. to give notice of any adopted changes, and in general. to proceed with the studies and labors with which it is seized in the interest of the postal union. It prepares a table of general statistics for each year: it edits a special journal "L'Union postale" in the German, French, and English languages; it prepares the work of the Congresses or Conferences, publishes and keeps up to date a dictionary of all the postoffices in the world, and attends to the balancing and liquidation of the accounts between the various postal administrations which have declared their willingness to make use of it as an intermediary. The total amount of the liquidations in 1902 reached the considerable sum of 49,113,785.57 francs ($9,822,757.11). Throughout the territory controlled by the Union, 24,061,000,000 pieces were exchanged in 1901; of these 51 000,000 were letters and packages having a declared value of 45,283,000,000 francs ($9,056,600,000); 460,000,000 postal orders were sent, amounting to 24,147,000,000 francs ($4,829,800,000); moreover, 2,275,000 000 journals were delivered through the postal bureau for subscriptions to such publications.

III. INTERNATIONAL BUREAU OF TELEGRAPHS.

This bureau is a central organ instituted in 1868 by the International Telegraphic Conference at Vienna and placed by it under the high direction of the superior authorities of the Swiss Confederation. Its object is to form a permanent bond between the telegraphic services of the different states which compose the Union, to facilitate the uniform application of the arrangements they have resolved upon, to collect and redistribute documents and information of mutual utility, to carry on such work and publications as are of interest to the service, notably to prepare work for the Conferences and publish their acts. This bureau has its seat in Bern, and its expenses are temporarily advanced by the Swiss Confederation, which is later reimbursed by the members of the Union, of whom there at present 47, covering a superficial area of 62,100,000 square kilometers, (23,970,000 square miles), and comprising within its circuits a population of 866,000,000 souls.

The recent Conference at London in 1903 simplified the matters of tariff and accounting very greatly. The participants in the benefits of this treaty are now: The whole of Europe, British India, the Dutch Indies, Ceylon, the Portuguese colonies in Asia, Siam, French Cochin-China, Pers a, Japan, Asiatic Russia, and Asiatic Turkey, Egypt, Tunis, Cape Colony, Natal, East African colonies, and the British protectorate of Uganda, Portuguese East and West Africa, Madagascar, Algiers and Senegal, the Republics of Argentine, Brazil and Uruguay, the Australian Confederation, comprising South and West Australia, New South Wales, Queensland, Tasmania, Victoria, New Zealand and New Caledonia. Besides the countries above mentioned, the following are intimately connected with the general system which encircles the globe: China, the Philippines, British America, the United States, almost all the Greater and Lesser Antilles, Central and South America, Morocco at Tangier, the Azores, Island of Madeira, the Canaries and Cape Verde Islands, as well as those of Ascension and St. Helena, the Eastern and Western coasts of Africa, together with the islands of Seychelles, Maurice, Rodriguez, Cocos, and so forth.

It is estimated that the number of dispatches forwarded in 1901 by the countries above named amounted to more than 400,000,000.

IV. INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES.

By virtue of the Metric Convention signed at Paris, May 20, 1875, the States of Germany, Argentine Republic, Austria-Hungary, Belgium, Denmark, Spain, United States, France, Italy, Peru, Portugal, Russia. Sweden and Norway. Switzerland, and Venezuela, engaged to found and sustain, at common expense, an International Bureau of Weights and Meas-

ures, of which the seat should be at Sevres, near Paris. It is furthermore stipulated in that Convention, that the Bureau should perform its labors under the surveillance of an international committee, itself subject to a general Conference of weights and measures composed of all the delegates from the contracting States. This convention became operative from the first of January, 1876.

V. INTERNATIONAL UNIONS FOR THE PROTECTION OF INDUSTRIAL, LITERARY AND ARTISTIC PROPERTIES.

The Union for the Protection of Industrial Property was founded at Paris, March 20, 1883, by a convention to which 19 States were parties. They were Belgium, Brazil, Denmark, France, Germany, Great Britain, Holland, Italy, Japan, Mexico, Norway and Sweden, Portugal, Servia, Spain, Santo Domingo, Switzerland, Tunis, and the United States. The object of the union is to assure the protection of inventions, designs and models of an industrial character, trademarks, firm names and indications of origin. This convention was completed and modified by an additional act signed at Brussels, December 14, 1900.

Moreover, on April 14, 1891, agreements were signed at Madrid constituting restrictive unions, viz.: 1. International registration of manufacturing and trademarks and the protection of these marks in all the contracting countries by the single registration at an International Bureau. The parties to this agreement were Belgium, Brazil, France, Holland, Italy, Portugal, Spain, Switzerland, and Tunis. 2. The suppression of false indications of origin: Brazil, France, Great Britain, Portugal, Spain, Switzerland, and Tunis. The arrangement of 1891, concerning the international registration of Marks, was completed and modified by an additional act signed at Brussels, December 14, 1900.

The Union for the Protection of Literary and Artistic Property, founded at Bern, September 9, 1886, comprised fourteen states: Belgium, Denmark, France, Great Britain, Germany, Haïti, Italy, Japan, Luxemburg, Monaco, Norway, Spain, Switzerland, and Tunis.

The object of this union is to assure effective protection to authors for their literary works, and to enable artists to enjoy the same security in their artistic productions throughout the whole territory covered by the union. This convention was completed and modified by an additional act and an interpretative declaration signed at Paris, May 4, 1896. Both of these unions are represented by a separate International Bureau established at Bern, and placed under the same directorate.

VI. BUREAU FOR THE REPRESSION OF THE SLAVE TRADE ON THE AFRICAN COAST.

This bureau was instituted in the execution of the General Act of the Conference of Brussels of the 2d of July, 1890, and attached to the Department for Foreign Affairs of Belgium.

Article 81.—The Powers will communicate to the greatest extent possible and with the least possible delay:

1. The text of the existing laws and administrative regulations or edicts for the application of the clauses of the present General Act.
2. Statistical information concerning the slave trade; slaves taken and freed; the traffic in arms and ammunition, and also in spirits.

Article 82.—The exchange of these documents and circulars will be centralized in a special bureau attached to the Department of Foreign Affairs at Brussels.

Article 84.—The documents and circulars shall be collected and periodically published, and forwarded to all the signatory powers.

Article 85.—The expenses of running the bureau, of correspondence, of translation and printing, shall be met by all the signatory powers, and recovered by the Department of Foreign Affairs at Brussels.

VII. INTERNATIONAL UNION FOR THE PUBLICATION OF CUSTOMS TARIFFS.

The International Union for the Publication of Customs Tariffs was founded by an international convention, July 5, 1890, and concluded between fifty-two states and semi-independent colonies. The object of the union is to publish as promptly and as correctly as possible all the tariffs of the world in five languages, viz., English French, German, Italian, and Spanish. The bureau has its seat at Brussels, and is under the direct control of the Government of Belgium. The members

of the bureau are delegates from the principal countries whose language is used in the publications.

VIII. INTERNATIONAL BUREAU OF RAILROAD TRANSPORTATION.

On October 14, 1890, an international convention upon the transportation of merchandise by railroad was concluded at Bern, between Germany, Belgium, France, Italy, Luxemburg, Holland, Austria-Hungary, Russia, and Switzerland. Denmark and Roumania came in later.

The object of this convention was to regulate the law governing international transportation between the directorates of the railways and the shippers. To facilitate the execution of this convention an international railway transportation bureau was instituted at Bern.

IX. CENTRAL BUREAU OF INTERNATIONAL GEODESY ESTABLISHED UPON THE TELEGRAPHBERG, NEAR POTSDAM.

This central bureau has existed since 1866. After the creation of the Prussian Geodetic Institute it was united with the latter in 1869. The object of the Geodetic Institute is to cultivate geodesy by scientific researches, to execute the astronomical and physical determinations which, joined with the geodetic determinations, may serve in the exploration of the surface of the earth, more particularly within Prussian territory.

The labors of the institute for the present bear more particularly upon the astronomical determinations of the vertical in longitude and latitude, as well as upon astronomical data upon as many points of the geodetic system as possible; moreover, upon the determination of zenithal distances for convenient points, also upon the determination of the density and force of gravitation; it devotes its attention, furthermore, to researches upon the mean level and variations in the sea-level; to the examining into the refraction of luminous rays by the atmosphere; finally, it is occupied with all theoretical and experimental researches which contribute to the examination of the surface and the geodesy of the country.

The Geodetic Institute is placed under the immediate supervision of the Minister of Ecclesiastical Affairs, Public Instruction, and Medical Affairs of Prussia.

The Academy of Sciences is the consulting organ of the Minister in all the important affairs of the Institute. Conformably to the conventions agreed upon between the contracting parties, the Institute performs the functions of a Central Bureau for international geodesy. The director of the bureau is at the same time director of the Institute.—Almanach de Gotha.

CARNEGIE HERO COMMISSION.

Mr. Andrew Carnegie gave $5,000,000 for a fund to be known as the "Carnegie Hero Fund Commission," the interest being devoted to the reward of those who perform heroic acts. The fund became operative April 15, 1904, and no applications on account of heroic acts performed prior to that date will be considered. The headquarters of the fund are in Pittsburg.

RHODES SCHOLARSHIPS.

By his will, Mr. Cecil Rhodes, in his desire to encourage and foster an appreciation of the advantages which will result from the union of the English-speaking people throughout the world, and to encourage in students from the United States of America an attachment to the country from which they have sprung, without withdrawing their sympathies from the land of their adoption or birth, directs his trustees to establish sixty colonial scholarships for male students of $1,500 each a year for three years at the University of Oxford, these colonial scholarships being spread over most of the colonies, twenty-four being allotted to South Africa.

Two Oxford scholarships are to be allotted to each of the existing States and Territories of the United States of America—104 in all. By a codicil executed in South Africa, Mr. Rhodes, after stating that the German Emperor had made instruction in English compulsory in German schools, establishes fifteen scholarships for students of German birth (five in each of the first three years after his death), of $1,250 each, tenable for three years, to be nominated by the German Emperor, for "a good understanding between

England, Germany, and the United States of America will secure the peace of the world, and educational relationships form the strongest tie."

So that the students who shall be elected to the scholarships shall not be merely bookworms, regard is to be had, not only to their "literary and scholastic attainments," but also to their "fondness of and success in manly outdoor sports, qualities of manhood, truth, courage, devotion to duty, sympathy for and protection of the weak, kindliness, unselfishness, and fellowship," moral force of character and instincts of leadership. "No student shall be qualified or disqualified for election to a scholarship on account of his race or religious opinions." The scholars are to be distributed among all the colleges of the University of Oxford, and there is to be an annual dinner of past and present scholars and trustees.

Dr. G. R. Parkin, Principal of the Upper Canada School, Toronto, was appointed organizing agent for the trustees.—"Daily Mail" Year Book.

THE CARNEGIE INSTITUTION.

This institution was founded by Mr. Andrew Carnegie for the promotion of original research in science, literature and art. He set aside $10,100,000 for the purpose. The interest is used to conduct, endow and assist investigation in any department of science, literature, or art and to this end co-operate with governments, universities, colleges, technical schools, learned societies, and individuals. The headquarters of the institution are in Washington. Prof. D. C. Gilman is the President, and Mr. Charles D. Walcott is the Secretary. Many grants have already been made, and the investigations have been important.

CHAPTER XIV.

MINES AND MINING.

SUMMARY OF THE MINERAL PRODUCTION OF THE UNITED STATES IN 1902.

GENERAL REMARKS.

In 1902, for the third time, the total value of the commercial mineral production of the United States exceeded the enormous sum of $1,000,000,000. The exact figures for 1902 were $1,260,639,415 as compared with $1,086,584,851 in 1901, with $1,063,678,053 in 1900, and with $972,208,008 in 1899, a gain of 1902 over 1901 of $174,064,414, or 16.02 per cent; a gain of 1902 over 1900 of $196,961,362, or 18.52 per cent; and a gain of 1902 over 1899 of $288,431,407, or 29.67 per cent. Although this gain is not so great either actually or proportionally as was the gain in 1899, when the gain over 1898 was $273,601,810, or 39.17 per cent, it is sufficient to be worthy of note.

The notable gains and losses of the last two decades are as follows:

The largest actual gain was that of 1899 over 1898, $273,601,810, or 39.17 per cent; next, that of 1902 over 1901, $174,053,760, or 16.02 per cent; then the gain of 1895 over 1894, which was $94,215,822, or 17.88 per cent; then that of 1900 over 1899, $91,468,340, or 9.41 per cent; and the gain of 1887 over 1886, $74,927,880, or 16.81 per cent. In other years than those mentioned between 1880 and 1898 the gains were not noteworthy, and in some of the years, notably in 1884, the production decreased $40,451,968, or nearly 9 per cent. During the industrial depression of 1892-1895 the production would have been expected to decline, as it did, going from $648,895,031 in 1892 to $574,464,724 in 1893, and to $527,079,225 in 1894, and then rising to $621,295,047 in 1895, and not reaching the output of 1892 until 1898.

As heretofore, iron and coal are the most important of our mineral products. The value of the iron in 1902 was $372,775,000; the value of coal $367,032,069. Nearly all the important metals increased in both output and value; and among the less important metals, platinum, as compared with 1901, lost in both quantity and value even more than it gained in 1901 as compared with 1900, the production in 1902 being 94 ounces, valued at $1,814, as compared with 1,408 ounces, valued at $27,526, in 1901, with 400 ounces in 1900, and with 300 ounces in 1899. The fuels increased from $442,410,904 in 1901 to $469,078,647 in 1902, a gain of $26,667,743, or 6 per cent. Every variety of fuel increased in value except anthracite coal, which showed a decrease in quantity of 23,301,850 long tons and in value of $36,330,434. The average price of anthracite coal per long ton at the mine was $2.35, as against $2.05 in 1901—the highest figure then obtained since 1888—as compared with $1.85 in 1900, and with $1.80 in 1899; and the average price per ton for bituminous coal at the mine was $1.125, as compared with $1.047 in 1901. The increase in value of the bituminous coal output over 1901 was $54,436,434.

The gain of $174,064,414 in the total value of our mineral production is due to the increase in both metallic and nonmetallic products, the metallic products showing an increase from $518,266,259 in 1901 to $642,258,584 in 1902, a gain of $123,992,325, and the nonmetallic products showing an increase from $567,318,592 in 1901 to $617,380,831 in 1902, a gain of $50,072,089. To these products should be added estimated unspecified products, including building, molding and other sands reported to this office, the rare mineral molybdenum, and other mineral products, valued at $1,000,000, making the total mineral production for 1902 $1,260,639,415.

The manufacture of arsenious oxide, noted for the first time in the United

States in the report for 1901, was continued in increased proportions in 1902.

METALS.

Iron and Steel.—Twenty-two States made pig-iron in 1902, as against 21 in 1899 and 1900, and 20 in 1901. The total production of pig-iron in 1902 was 17,821,307 long tons, against 15,878,354 tons in 1901, 13,789,242 tons in 1900, 13,620,703 tons in 1899, 11,773,934 tons in 1898, and 9,652,680 tons in 1897. The production of 1902 shows an increase of 1,942,953 long tons, or 12.2 per cent, in quantity over the production of 1901, and in increase in value from $242,174,000 to $372,775,000, amounting to $130,601,000, or about 54 per cent. The average price per long ton of pig-iron increased from $15.25 in 1901 to $20.90 in 1902. The average prices per long ton in recent years have been as follows: 1900, $18.85; 1899, $18; 1897, $9.85; 1896, $10.47; 1895, $11.14; 1894, $9.76.

Iron Ores.—The production of iron ores in 1902 amounted to 35,554,135 long tons, as compared with 28,887,479 long tons, in 1901, a gain of 6,666,656 long tons, or 23 per cent. The value at the mines of the ore mined in 1902 was $65,412,950. As in the four previous years, the production of iron ores in 1902 in the United States has never been equaled by any other country. There were mined also in 1902, 13,275 long tons of manganiferous iron ore, valued at $52,371, which were used in the production of spiegeleisen.

Gold.—The production of gold in 1902, as reported by the Bureau of the Mint, was 3,870,000 fine ounces, valued at $80,000,000.

Silver.—The production of silver in 1902, as reported by the Bureau of the Mint, was 55,500,000 fine ounces; coining value, $71,757,575; commercial value, $29,415,000.

Manganese Ores.—The production of manganese ores increased from 11,995 long tons, valued at $116,722, in 1901, to 16,477 long tons, valued at $177,911, in 1902, an increase in quantity of 4,472 tons and in value of $61,189. The average price per ton was $10.74 in 1902, as compared with $9.73 in 1901 and with $8.52 in 1900.

Copper.—The copper mining industry suffered during 1902 from the reaction which followed the unsuccessful attempt in 1901 to maintain the metal at an artificial level. The production, however, increased from 602,072,519 pounds in 1901 to 659,508,644 pounds in 1902, an increase of 57,436,125 pounds, or about 9 per cent, in quantity, but decreased in value from $87,300,575 in 1901 to $76,568,954 in 1902, a decrease of $10,731,561, or about 12 per cent. Unless unforeseen events cause widespread or long stoppage at the mines, the production of copper in the United States will be considerably larger in 1903 than it has ever been.

Lead.—The production of lead has been almost exactly the same for the last three years, viz., 270,000 short tons in 1902, 270,700 short tons in 1901 and 270,824 short tons in 1900. The value of the production in 1902 was $22,140,000, as compared with $23,280,200 in 1901, and with $23,564,688 in 1900.

Zinc.—The production of zinc in 1902 showed a continued increase in quantity as compared with 1901 and 1900, the production being 156,927 short tons in 1902, as compared with 140,822 short tons in 1901 and with 123,886 short tons in 1900. The value of the zinc production in 1902 was $14,625,596, as compared with $11,265,760 in 1901 and with $10,654,196 in 1900.

Aluminum. — The production of aluminum during 1902 was 7,300,000 pounds, valued at $2,284,590, as compared with 7,150,000 pounds, valued at $2,238,000 in 1901, and with 7,150,000 pounds, valued at $1,920,000 in 1900.

Platinum.—The production of platinum from domestic ores in the United States during 1902 was 94 ounces, valued at $1,814, as compared with 1,408 ounces, valued at $27,526 in 1901.

Quicksilver. — The production of quicksilver during 1902 amounted to 34,291 flasks of 76½ pounds net, as compared with 29,727 flasks in 1901 and with 28,317 flasks in 1900. The value of the quicksilver produced in 1902 was $1,467,848, as compared with $1,382,365 in 1901 and with $1,302,586 in 1900. California reported 28,972 flasks in 1902, as compared with 26,720 flasks in 1901; and Texas reported 5,319 flasks in 1902, as against 2,932 flasks in 1901. In addition, the census reports 10,427 tons of crude or cinnabar, valued at $67,242, mined in California, and 1,300 tons of cinnabar, valued at $1,500, mined in Texas in 1902, but not roasted or treated, a total of 11,727 short tons of cinnabar, valued at

$82,242. The total production of both quicksilver and cinnabar in 1902 was therefore valued at $1,550,090.

Lithium.—The production of lithium minerals in 1902 was 1,245 short tons, valued at $25,750 at the railroad, a decrease of 505 tons in amount and of $17,450 in value as compared with the production of 1901, which was 1,750 tons, valued at $43,200. As far as can be ascertained the greater part of the lithium minerals mined during 1902 was not shipped. Although the price of these minerals was lower in 1902 than in 1901 for the same grade of mineral, there was apparently no increase in the home demand. There is, however, an increase in the demand for these minerals from foreign chemical manufacturers.

Nickel.—The production of metallic nickel in 1902 was 5,748 pounds, valued at $2,701, as compared with 6,700 pounds, valued at $3,551 in 1901.

Antimony.—No antimony was obtained from domestic ores during 1902. The antimony obtained from the smelting of foreign imported ores amounted to 657 short tons, valued at $129,126, and the antimony obtained from hard lead produced from foreign and domestic lead ores was 2,904 short tons, valued at $505,240, a total production for 1902 of 3,561 short tons, valued at $634,506, as compared with 2,639 short tons, valued at $539,902, in 1901. The estimated total amount of antimony available for consumption in 1902 was 6,255 short tons, including 2,694 short tons of imported antimony regulus, as compared with 4,475 short tons, including 1,837 short tons of imported antimony regulus in 1901, and with 6,053 short tons, including 1,827 short tons of imported antimony regulus in 1900.

Bismuth.—No bismuth ores were produced in the United States during 1902. The marketed output in 1901 was 318.6 short tons. The ore contained gold and silver, for which the producers were paid. As nearly as can be ascertained, the value of the output in 1901 was $80 per ton, not including charges for transportation or treatment.

Molybdenum.—The production of molybdenum in 1902 was approximately the same as that of 1901, but none of the product was shipped in 1902. The value of these molybdenum ores is very erratic, the highest price hitherto quoted being $1,500 per ton, and the lowest $100.

Tungsten.—The production of tungsten during 1902 was 184 short tons of crude ore, of which no more than a few tons were sold. This does not represent the amount of tungsten ore sold in 1902, for 76 tons of concentrated ore, mined in 1901, were sold in 1902. In 1901 the production amounted to 179 tons of concentrated ore, valued at $27,720. The larger part of the production of 1902 was from Colorado.

Uranium and Vanadium. — There was a marked increase in the production of uranium and vanadium minerals in 1902, which, as reported to the Survey, amounted to 3,810 short tons, valued at $48,125, or $12.62 per ton. This, of course, represents the crude ore. In 1901 the production was 375 tons of crude ore.

FUELS.

Coal.—For the first time in the history of the United States the production of coal reached a total of over 300,000,000 short tons, showing an actual output of 301,590,439 tons of 2,000 pounds, valued at $367,032,069. Of this total the output of anthracite coal amounted to 36,940,710 long tons (equivalent to 41,373,595 short tons), which, as compared with the production of 60,242,560 long tons in 1901, was a decrease of 23,301,850 long tons, or about 39 per cent. This decrease, as is well known, was due entirely to the suspension of operations by the strike in the anthracite region from May 10 to October 23, a little over five months. But for the strike the output for the year would probably have been over 65,000,000 long tons. The value at the mines of the anthracite coal in 1902 was $76,173,586, as against $112,504,020 in 1901, a loss of about 32.3 per cent. The average value of the marketed coal sold during the year at the mines was $2.35 per long ton, the value in 1901 having been $2.05.

The output of bituminous coal (which includes semi-anthracite and all semi-bituminous and lignite coals) amounted in 1902 to 260,216,844 short tons, valued at $290,858,483, as against 225,828,1'9 short tons, valued at $236,422,049 in 1901. The increase in the production of bituminous coal was, therefore, 34,388,695 tons in quantity and $54,436,434 in value.

Out of 30 States and Territories producing coal in 1902, seven—California, Michigan, New Mexico, Oregon, Pennsylvania, Texas and Washington—had smaller outputs than in 1901.

The production of bituminous coal in Pennsylvania in 1902 exceeded that of 1901 by 15,755,874 short tons, but was not sufficient to overcome the great loss in anthracite production. The States in which the more important increases occurred with the corresponding gains are as follows: Illinois, 5,547,751 short tons; Colorado, 2,314,412 short tons; Ohio, 2,444,577 short tons; Indiana, 2,268,371 short tons; Alabama, 1,490,865 short tons; Kentucky, 1,193,176 short tons.

Coke.—The coke production of the United States in 1902 exceeded that of any year in our history. The production, which includes the output from 1,663 retort or by-product ovens, amounted to 25,401,730 short tons, as compared with 21,795,883 short tons in 1901, and with 20,533,348 short tons in 1900. The increase in 1902 over 1901 amounted to 3,605,847 short tons, or 16.5 per cent. Large as this increase was, it was considerably less than it would have been had the transportation facilities been commensurate with the demand for coke and with the productive capacity of the ovens. The increase in the value of coke was even more noteworthy. The average price per ton at the ovens was the highest recorded in a period of twenty-three years, and the total value reached the high figure of $63,339,167, an increase over 1901 of $18,893,244, or 42.5 per cent. The value of the coal used in the manufacture of coke in 1902 exceeded that of 1901 by $7,932,563, from which it appears that the value of the coke product increased $10,970,681 over and above the increased value of the coal used in its production. In 1901 the highest price obtained for Connellsville furnace coke was $4.25. In September and October of 1902, while the contract coke was nominally quoted at $3 per ton, consumers were paying from $10 to $12 per ton for prompt delivery, and $15 was reported as paid for this fuel at one time. With the termination of the anthracite strike in the latter part of October prices for coke quickly declined, but in December of 1902 furnace coke for prompt delivery was still commanding $5 and $6 per ton, and contracts for delivery in the first six months of 1903 were made at from $3.75 to $4 per ton.

Gas, Coke, Tar and Ammonia.—The aggregate value of all the products obtained from the distillation of coal in gas works or retort ovens in 1902 was $43,869,440. About two-thirds of this amount, or $29,342,881, was represented by the value of the gas produced. The value of the coke produced was $11,267,608, and the tar was worth, at the works, $1,873,966. The total quantity of ammoniacal liquor sold was 49,490,609 gallons, containing 14,683,374 pounds NH_3, and was worth at the works $1,065,300. In addition to this there was an actual production of 11,276,502 pounds of sulphate, which sold for $319,685.

Petroleum.—The total production of crude petroleum in the United States in 1902 was 88,766,916 barrels, as against 69,389,194 barrels in 1901, an increase of 19,377,722 barrels, or 27.92 per cent, over the production of 1901 and of 39.52 per cent over that of 1900. The greatest portion of the increase in 1902 came from Texas and California, the gain over 1901 being 13,690,000 barrels, or 311.6 per cent, for Texas, and 5,197,938 barrels, or 59.16 per cent, for California. The increase in Indiana in 1902 over 1901 was 1,723,810 barrels, or about 30 per cent. Louisiana produced for the first time in 1902, the production being 548,617 barrels. The increase over 1901 in the production of Kansas was 152,598 barrels, or about 85 per cent. Kentucky and Tennessee increased their production in 1902 by 48,072 barrels, or nearly 35.02 per cent. Indian Territory increased 37,000 barrels and Wyoming 853 barrels as compared with 1901. The largest decrease in production in 1902 as compared with 1901 was in West Virginia, where it amounted to 663,781 barrels, or about 4.5 per cent, and Ohio in 62 fields showed a decrease of 633,852 barrels, or nearly 3 per cent. The decrease in Pennsylvania was 561,888 barrels, or about 7 per cent; in Colorado, 63,619 barrels, or about 13.81 per cent. The percentages of production for fields show a remarkable change from 1900 to 1902. In 1900 the percentages were: Appalachian field, 57.05; Lima-Indiana field, 34.20; all other fields, 8.75. In 1902 the respective percentages were: Appalachian field, 36.07; Lima-Indiana field, 26.31; all other fields, about 37.62. The value of crude petroleum produced during 1902 was $71,178,910, or 80.19 cents per barrel, as compared with $66,417,335, or 95.7 per barrel, in 1901—a decrease of 15.51 cents per barrel, or 16 per cent, in 1902.

Natural Gas.—The value of the natural gas produced in 1902 increased to $30,867,668, as compared with $27,067,500 in 1901, with $23,698,674 in

1900, and with $20,074,873 in 1899—a gain of 13 per cent in 1902 over 1901.

STRUCTURAL MATERIALS.

Stone.—The value of all kinds of building stone produced in the United States during 1902 amounted to $64,-559,099, as compared with $55,615,-926 in 1901, with $44,321,345 in 1900, and with $44,090,670 in 1899.

Clay Products.—The activity in all branches of the clay-working industries noted in 1899, 1900 and 1901, continued during 1902. The value of all clay products as reported to the office of the Geological Survey in 1902 was $122,169,531, as compared with $110,211,587 in 1901, and with $96,-212,345 in 1900. The brick and tile products in 1902 were valued at $98,-042,078, as compared with $87,747,727 in 1901 and with $76,413,775 in 1900. The pottery products were valued in 1902 at $24,127,453, as compared with $22,463,860 in 1901 and with $19,798,-570 in 1900.

The clay mined and sold by those not manufacturing the product themselves in 1902 was valued at $2,061,-072, as compared with $2,576,932 in 1901 and with $1,840,377 in 1900.

Cement.—The total production of hydraulic cement in the United States in 1902 was 25,753,504 barrels, valued at $25,366,380, as compared with 20,-068,737 barrels, valued at $15,786,789, in 1901, and with 17,231,150 barrels, valued at $13,283,581, in 1900. The Portland cement production in 1902 was 17,230,644 barrels, valued at $20,-864,078, as compared with 12,711,225 barrels, valued at $12,532,360, in 1901, and with 8,482,020 barrels, valued at $9,280,525, in 1900, an increase, as compared with 1900, in quantity of about 100 per cent, and in value of over 50 per cent. The number of plants using Portland cement increased from 50 in 1900 to 56 in 1901, and to 65 in 1902. The production of natural rock cement in 1902 was 8,-044,305 barrels, valued at $4,076,630, as compared with 7,084,823 barrels, valued at $3,056,278, in 1901, and with 8,383,519 barrels, valued at $3,728,848, in 1900. The production of slag cement amounted to 478,555 barrels, valued at $425,672, in 1902, as compared with 272,689 barrels, valued at $198,-151, in 1901, and with 365,611 barrels, valued at $274,208, in 1900.

ABRASIVE MATERIALS.

Carborundum.—There was a slight decrease in the quantity of carborundum—3,741,500 pounds produced in 1902, as compared with 3,838,175 pounds in 1901—due in part to lack of a sufficient supply of raw materials, a result of the anthracite coal strike. The value of the carborundum varies from 8 to 10 cents per pound.

Corundum and Emery.—The combined production of corundum and emery in 1902 amounted to 4,251 short tons, valued at $104,605, as compared with 4,305 short tons, valued at $146,-040, in 1901, a decrease of 54 tons in quantity and of $41,435 in value.

Crushed Steel.—The production of crushed steel in 1902 was 735,000 pounds, as compared with 690,000 pounds in 1901, and the product is quoted at 5½ cents per pound free on board at Pittsburg.

Crystalline Quartz.—In 1902 the production of crystalline quartz included under abrasives amounted to 15,104 short tons, valued at $84,335, as compared with 14,050 short tons, valued at $41,500, in 1901. This large variation in value is due to the fact that in 1902 the value reported was in some cases that of the quartz after it had been crushed or ground. The actual value of the crude quartz produced in 1902 was $43,085.

Garnet.—The production of abrasive garnet in the United States during 1902 amounted to 3,926 short tons, valued at $132,820, as compared with 4,444 short tons, valued at $158,100, in 1901, and with 3,185 short tons, valued at $123,475, in 1900. As reported to the Survey the prices varied from $20 to $60 a ton, the highest price being obtained for the North Carolina garnet. The average value per ton of the production in 1902 was $35.10, as compared with $35.57 per ton in 1901 and with $38.77 in 1900.

Grindstones.—The total value of all kinds of grindstones produced during 1902 was $667,431, as compared with $580,703, in 1901, an increase of $86,-728. The production of 1900, valued at $710,026, still remains the largest on record for any year. It should be remembered, however, that the price per ton has decreased from $15 to from $8 to $10, and that therefore the tonnage of grindstones used has correspondingly increased within the last few years. The imports for 1902 amounted in value to $76,906, as compared with $88,871 in 1901 and with $92,581 in 1900.

Infusorial Earth and Tripoli.—In 1902 the production of infusorial earth and tripoli amounted to 5,665 short

tons, valued at $53,244, including 175 short tons mined as a by-product and valued at $1,436, an increase of 1,645 tons in quantity and of $294 in value, as compared with the production of 4,020 tons, valued at $52,950, in 1901.

Millstones and Buhrstones.—The value of the production of millstones and buhrstones in 1902 was $59,808, an increase of $2,629 over the value of 1901, which was $57,179. The value for 1902 was almost twice the value of the production of 1900, which amounted to $32,858. From 1886 to 1894 there was a very large decrease—from $140,000 to $13,887—in the production of buhrstones. Since 1894 there has been a gradual increase in the production.

Oilstones and Whetstones.—There was a decided increase in the domestic commercial production of oilstones and whetstones during 1902, the value of which amounted to $221,762, as compared with $158,300 in 1901, an increase in 1902 of $63,462. Until 1902, the year of maximum production was 1899, when the value of the output amounted to $208,283. The crude production of oilstones and whetstones in 1902, as reported by the census, was valued at $113,968.

Pumice.—The volcanic ash deposits in Nebraska were worked to some extent in 1902, the product being used in the manufacture of certain soaps and scouring powders. The production of pumice amounted to 700 short tons, valued at $2,750.

CHEMICAL MATERIALS.

Arsenious Oxide.—The domestic production of arsenious oxide (white arsenic) in 1902 was 1,353 short tons, valued at $81,180, as compared with 300 short tons, valued at $18,000, in 1901. The entire product was made by the Puget Sound Reduction Company at Everett, Wash., which began the manufacture of this important substance in 1901. The largely increased output in 1902 is a sign of the success of the new industry.

Borax.—The reported returns for 1902 gave an aggregate commercial production of crude borax of 2,600 short tons, valued at $91,000, of refined borax and boric acid, amounting to 17,404 short tons, valued at $2,447,614, of which it was stated that 862 short tons, valued at $155,000, were boric acid. This gives a total production for 1902 of 20,004 short tons, valued at $2,538,614. The production during 1901 was 17,887 short tons of crude borax and 5,344 short tons of refined borax, with a total value of $1,012,118.

Bromine.—The production of bromine in 1902, including the amount of bromine contained in potassium bromide, amounted to 513,890 pounds, valued at $128,472, as compared with 522,043 pounds, valued at $154,572, in 1901, a decrease for the year of 38,153 pounds in quantity and of $26,100 in value. The price per pound during 1902 averaged 25 cents, as compared with 28 cents in 1901 and with 29 cents in 1900. There has been practically no change in the bromine industry in the United States in 1902.

Fluorspar.—There was a large increase in the production of fluorspar in 1902 over that of 1901, due partly to its increased use for metallurgic purposes. The total production in 1902 was 48,018 short tons, valued at $271,832, as compared with 19,586 tons, valued at $113,803, in 1901. This increase in production was not due to any one State, but there was a large increase in production in both Illinois and Kentucky, and also an increase in Arizona. The average price of crude fluorspar was reported as $5.19 per ton, as compared with $5 in 1901, and the average price of ground fluorspar was $9.98 per ton, as compared with $9.22 in 1901. In addition to this production there were 800 short tons, valued at $3,850, mined but not marketed in 1902.

Gypsum.—The production of gypsum, particularly for the manufacture of calcined plaster, continues to show a remarkable gain. The output of crude gypsum in 1902 was 816,478 short tons, valued in its first marketable condition at $2,089,341, as compared with 633,791 short tons, valued at $1,506,641, in 1901, and with 595,462 short tons, valued at $1,627,203, in 1900. The production in 1899 was 486,235 short tons, and in 1898 it was 291,638 short tons. The greatly increased production of the last four years is attributable to the largely increased use of plaster of paris in the large modern buildings and in the manufacture of staff for temporary buildings.

Marls.—The production of marls in the United States in 1902 was 12,439 short tons, valued at $12,741.

Phosphate Rock.—The total commercial production of phosphate rock reported to the Survey in 1902 amounted to 1,490,314 long tons, val-

ued at $4,693,444, as compared with 1,483,723 long tons, valued at $5,316,-403, in 1901, an increase in quantity of 6,591 tons and a decrease in value of $622,959. The total quantity of phosphate rock reported as mined during 1902 was 1,548,720 long tons, valued at $4,922,943, as compared with 1,440,408 long tons in 1901.

Salt.—The salt product includes salt in the form of brine used in large quantities for the manufacture of soda ash, sodium bicarbonate, caustic soda and other sodium salts. The domestic production of salt in 1902 amounted to 23,849,221 barrels of 280 pounds net, valued at $5,668,636, as compared with 20,556,661 barrels, valued at $6,-617,449, in 1901, and with 20,869,342 barrels, valued at $6,944,603, in 1900.

Sulphur and Pyrite.—The domestic production of sulphur and of pyrite for the manufacture of sulphuric acid amounted in 1902 to 207,874 long tons, valued at $947,089, as compared with a combined production of 241,691 long tons, valued at $1,257,879, in 1901. The production of sulphur was from Louisiana, Nevada and Utah, named in the order of the importance of their outputs. Oregon and Idaho reported no production in 1902. The greater part of the output of pyrite was derived from Virginia, Georgia, North Carolina, Colorado and Massachusetts, named in the order of production.

PIGMENTS.

Barytes.—The production of crude barytes in 1902 was considerably in excess of that of the year before, amounting to 61,668 short tons, valued at $203,154, as compared with 49,-070 tons, valued at $157,844, in 1901. This is an increase of 12,598 tons in quantity and of $45,310 in value.

Cobalt Oxide.—The domestic production of cobalt oxide in 1902 was 3,730 pounds, valued at $6,714, as compared with 13,360 pounds, valued at $24,048, in 1901, a decrease in quantity of 9,630 pounds. All the cobalt oxide was obtained as a by-product in smelting lead ores at Mine Lamotte, Mo.

Mineral Paints.—The Commercial production of mineral paints in 1902 amounted to 73,049 short tons, valued at $944,332, as compared with 61,-460 short tons, valued at $789,962, in 1901. The production of crude mineral paints in 1902 is reported as 35,-479 short tons, valued at $360,885, including 4,500 tons, valued at $18,000, of ocher and metallic paint reported as mined but not marketed in 1902.

Zinc White.—The production of zinc white in 1902 amounted to 52,645 short tons, valued at $4,016,499, as compared with 46,500 short tons, valued at $3,720,000 in 1901.

MISCELLANEOUS.

Asbestos.—The commercial production of asbestos in the United States in 1902 was chiefly from the mines at Sall Mountain, White County, Georgia, with smaller quantities from Hillsdale, Berkshire County, Massachusetts. This production was 1,005 short tons, valued at $16,200, an increase of 258 tons in quantity and of $2,702 in value over the production of 1901, which was 747 short tons, valued at $13,498. The production in 1900 was 1,054 short tons, valued at $16,310. In addition there were reported as produced but not marketed in 1902 1,500 short tons of crude asbestos, valued at $30,000.

Asphaltum.—Under this title are included the various bitumens or hydrocarbons not discussed under the heading "Petroleum" in the volume on Mineral Resources. The commercial production of asphaltum in 1902 was 105,458 short tons, valued at $765,048, as compared with 63,134 short tons, valued at $555,335, in 1901—a large increase, amounting in quantity to 42,-324 short tons and in value to $209,-713. The production of crude asphaltum in 1902 is reported as 66,238 short tons, valued at $236,728.

Bauxite.—In 1902 the production of bauxite increased to 29,222 long tons, valued at $128,206, as compared with 18,905 long tons, valued at $79,914, in 1901. Georgia yielded the greater bulk of the product, the remainder being supplied by Alabama and Arkansas.

Chromic Iron Ore.—California was the one State to produce any chromite during 1902, the quantity being 315 long tons, valued at $4,567, a decrease of 53 tons in quantity and of $1,223 in value, as compared with the production of 1901, which was 368 long tons, valued at $5,790.

Feldspar.—The production of feldspar in 1902 was 45,287 short tons, valued at $250,424, as against 34,741 short tons, valued at $220,422, in 1901.

Fibrous Talc.—This variety of talc or soapstone occurs in but one locality in the United States—Gouverneur, St. Lawrence County, New York. It

is used principally as makeweight in the manufacture of paper. In 1902 the production was 71,100 short tons, valued at $615,350, an increase of $131,750 in value and of only 1,900 tons in quantity, as compared with the production of 69,200 short tons, valued at $483,600, in 1901.

Flint.—The production of flint in 1902 was 36,365 short tons, valued at $144,209, as compared with 34,420 short tons, valued at $149,297, in 1901.

Fuller's Earth.—As reported for the Survey, the production of fuller's earth in 1902 showed a decrease in quantity and an increase in value, being 11,492 short tons, valued at $98,144, as compared with 14,112 short tons, valued at $96,835, in 1901. The maximum production of fuller's earth was obtained in 1897, when the production was 17,113 short tons.

Glass Sand.—The production of glass sand in 1902 was 943,135 short tons, valued at $807,797; the production of engine, furnace, building, molding and other sands, mined incidentally, was 904,776 short tons, valued at $615,817—a total production of 1,847,901 short tons of sand, valued at $1,423,614.

Graphite.—The commercial production of crystalline graphite during 1902 amounted to 3,936,824 pounds, valued at $126,144, as compared with 3,967,612 pounds, valued at $135,914, in 1901, and with 5,507,855 pounds, valued at $178,761, in 1900. The commercial production of amorphous graphite in 1902 was 4,739 short tons, valued at $55,964, as compared with 809 short tons, valued at $31,800, in 1901. The decline in value was due to a proportionate increase in the production of the lower grades. Considerable development and exploratory work was done during the year in Montana, Wyoming, North Carolina and New Mexico. In addition, 30,000 pounds of refined graphite, valued at $1,800, and 20,716 short tons of crude graphite, valued at $43,600, were reported as produced but not marketed in 1902. This gives a total production of 3,966,824 pounds of refined graphite and of 25,455 short tons of amorphous graphite, with a total value of $227,508, as produced in 1902. The production of artificial graphite was 2,358,828 pounds, valued at $110,700, the average price being 4.69 cents per pound, as compared with 2,500,000, valued at $119,000, in 1901, the average price being 4.75 cents per pound.

Limestone for Iron Flux.—The quantity of limestone used for fluxing in blast furnaces in 1902 was 11,878,675 long tons, valued at $5,271,252, as compared with 8,540,168 long tons, valued at $4,659,836, in 1901, and with 7,495,435 long tons, valued at $3,687,394, in 1900.

Magnesite.—The production of magnesite in the United States continues to be limited to California, and during the year 1902 the commercial production reported was 3,466 short tons, valued at $21,362—a large decrease as compared with the production in 1901, which was 13,172 short tons, valued at $43,057. Of the 1902 production, 380 tons, valued at $1,723, were sold in 1902, but were mined previously.

Mica.—The production of mica in 1902 was as follows: 373,266 pounds of plate or sheet mica, valued at $83,843; 1,028 short tons of scrap mica, valued at $13,081, and 372 short tons of rough mica, valued at $21,925—a total value of $118,849.

Mineral Waters.—The total production of mineral waters for 1902 was 64,859,451 gallons, valued at $8,793,761, as compared with 55,771,181 gallons, valued at $7,586,962, in 1901—a gain in quantity of 9,088,263 gallons and in value of $1,206,799.

Monazite.—The production of monazite is confined exclusively to North Carolina and South Carolina, by far the larger quantity being obtained from the former State, and in 1902 this amounted to 802,000 pounds, valued at $64,160, as compared with 748,736 pounds, valued at $59,262, in 1901—an increase in quantity of 53,264 pounds and in value of $4,898. The price per pound received by the miners for the monazite produced in 1902 varied from 2.5 to 8 cents, according to the percentage of thoria.

Precious Stones.—The value of the gems and precious stones found in the United States in 1902 was $328,450, as compared with $289,050 in 1901, with $233,170 in 1900, and with $185,770 in 1899. There has been a great advance in the lapidary industry in the United States since 1894. The fact that larger establishments have been formed, which are able to purchase the rough diamonds in greater quantities, has placed our American diamond cutters in a position equal to that held by the cutters of Amsterdam, Antwerp and Paris. The cutting of our native gems has also grown to the proportions of an industry, notably in the case of the beryls and the amethyst found in North Carolina and Connecti-

cut; the turquoise from New Mexico, Arizona, Nevada and California; the fine-colored and deep-blue sapphires found in Montana; the colored tourmalines of San Joaquin County, California; the chrysoprase mine of Visalia, Tulare County, California; the garnets of Arizona and New Mexico, and the pale-purple garnets of North Carolina.

Rutile.—The production of rutile in 1902 was less than in 1901.

Soapstone.—Exclusive of the production of fibrous talc from Gouverneur, New York, the production of talc and soapstone in 1902 amounted to 26,854 short tons, valued at $525,157, as compared with 28,643 tons, valued at $424,888, in 1901—a decrease of 1,789 tons in quantity and an increase of $100,269 in value. The output for 1900 was 27,943 short tons, valued at $383,541, and for 1899 it was 24,765 short tons, valued at $330,805.—Mineral Resources of the United States.

MINERAL PRODUCTS OF THE UNITED STATES FOR THE CALENDAR YEAR 1902.

Product.		1902.	
		Quantity.	Value.
METALLIC.			
Pig iron (spot value)	long tons	17,821,307	$372,775,000
Silver, coining value	fine ounces	55,500,000	71,757,575
Gold, coining value	do.	3,870,000	80,000,000
Copper, value at New York City	lbs.	659,508,644	76,568,954
Lead, value at New York City	short tons	270,000	22,140,000
Zinc, value at New York City	do.	156,927	14,625,596
Quicksilver, value at San Francisco	flasks	[1] 34,291	1,467,848
Aluminum, value at Pittsburg	lbs.	7,300,000	2,284,590
Antimony, value at San Francisco	short tons	3,561	634,506
Nickel, value at Philadelphia	lbs.	5,748	2,701
Tin	do.	None.	....
Platinum, value (crude) at San Francisco	troy ounces	94	1,814
Total value of metallic products			$642,258,584
NON-METALLIC (SPOT VALUES).			
Bituminous coal	short tons	260,216,844	$290,858,483
Pennsylvania anthracite	long tons	36,940,710	76,173,586
Natural gas		....	30,867,668
Petroleum	bbls.	[2] 88,766,916	71,178,910
Brick clay		....	15,000,000
Cement	bbls.	25,753,504	25,366,380
Stone		....	64,559,099
Corundum and emery	short tons	4,251	104,605
Crystalline quartz	do.	15,104	[3] 84,335
Garnet for abrasive purposes	do.	3,926	132,820
Grindstones		....	667,431
Infusorial earth and tripoli	short tons	5,665	53,244
Millstones		....	59,808
Oilstones, etc.		....	[3] 221,762
Arsenious oxide	short tons	1,353	81,180
Borax (refined)	do.	[4] 17,404	2,447,614
Borax (crude)	do.	2,600	91,000
Bromine	lbs.	513,890	128,472
Fluorspar	short tons	[5] 48,018	271,832
Gypsum	do.	816,478	2,089,341
Lithium	do.	1,245	25,750
Marls	do.	12,439	12,741

[1] In addition the census reports 11,727 short tons of cinnabar, valued at $82,242, as mined but not marketed in 1902.

[2] In addition the census reports 508,386 barrels of petroleum, valued at $218,829, as produced but not marketed in 1902.

[3] Value of crude production as reported by the census: Crystalline quartz, $43,085; oilstones, $113,968.

[4] Production in 1902, as reported by the census, 19,142 short tons, valued at $2,383,614.

[5] In addition the census reports 800 short tons of fluorspar, valued at $3,850, as mined but not marketed in 1902.

MINERAL PRODUCTS OF THE UNITED STATES FOR THE CALENDAR YEAR 1902.—*Continued.*

Product.		1902. Quantity.	1902. Value.
Phosphate rock	long tons	[6] 1,490,314	$4,693,444
Pyrite	do.	297,874	947,089
Salt	bbls.	23,849,221	5,668,636
Sulphur	short tons	(7)	(7)
Barytes (crude)	do.	61,668	203,154
Cobalt oxide	lbs.	3,730	6,714
Mineral paints	short tons	[8] 73,049	944,332
Zinc white	do.	52,645	4,016,499
Asbestos	do.	[9] 1,005	16,200
Asphaltum	do.	[10] 105,458	765,048
Bauxite	long tons	29,222	128,206
Chromic iron ore	do.	315	4,567
Clay (all other than brick)	short tons	1,455,357	2,061,072
Feldspar	do.	45,287	250,424
Fibrous talc	do.	71,100	615,350
Flint	do.	36,365	144,209
Fuller's earth	do.	11,492	98,144
Glass sand	do.	943,135	807,797
Graphite (crystalline)	lbs.	[11] 3,936,824	182,108
Graphite (amorphous)	short tons	4,739	
Limestone for iron flux	long tons	11,878,675	5,271,252
Magnesite	short tons	[12] 3,466	21,362
Manganese ore	long tons	16,477	177,911
Mica (sheet)	lbs.	373,266	83,843
Mica (scrap)	short tons	1,400	35,006
Mineral waters	gallons sold	64,859,451	8,793,761
Monazite	lbs.	802,000	64,160
Ozocerite (refined)	do.	None.	....
Precious stones		....	328,450
Pumice stone	short tons	700	2,750
Rutile	lbs.	(12)	....
Soapstone	short tons	26,854	525,157
Uranium and vanadium	do.	3,810	48,125
Total value of non-metallic mineral products		....	$617,380,831
Total value of metallic products		....	642,258,584
Estimated value of mineral products unspecified		....	1,000,000
Grand total		....	1,260,639,415

[6] The total quantity of phosphate rock mined in 1902 was 1,548,720 long tons, valued at $4,922,943.
[7] Included under pyrite.
[8] Production of crude material of mineral paints was 35,479 short tons, valued at $360,885.
[9] In addition, 1500 short tons of crude asbestos, valued at $30,000, are reported by the census as mined but not marketed in 1902.
[10] The production of the crude material is reported by the census as 66,238 short tons, valued at $236,728.
[11] In addition, graphite to the value of $45,400 is reported as mined but not marketed in 1902.
[12] The magnesite actually mined in 1902 is reported as 3,086 short tons, valued at $19,639.
[13] Included under estimated unspecified products.

Speeds for Grinding and Polishing, etc.

Speed of	Ft. per Min.
Large grindstones for polishing	2,000
Emery disks	2,500 to 3,000
Polishing large articles	750
Tool grinders	650
Circular saws for hot iron	20,000
Disintegrators	10,000
Plate-bending rolls	4
Millstones	17 000
Sack tackle	50

Depreciation of Machinery, etc., per Annum on First Cost.

Machinery, etc.	Depre-cia-tion.	Wear and Tear.	Total.
Engines	3%	3 %	6 %
Boilers	7%	3 %	10 %
Machines	5%	3 %	8 %
Millwork and gearing	3%	2½%	5½%
Bands and belts	....	45 %	45 %

MINES AND QUARRIES.

DETAILED SUMMARY, UNITED STATES: 1902.

Number of mines, quarries, or wells	151,516
Number of operators	46,858
Salaried officials, clerks, etc:	
Total number	38,128
Total salaries	$39,020,552
General officers—	
Number	4,591
Salaries	$8,218,541
Superintendents, managers, foremen, surveyors, etc—	
Number	15,538
Salaries	$16,666,416
Foremen, below ground*—	
Number	6,863
Salaries	$6,208,307
Clerks—	
Number	11,136
Salaries	$7,927,288
Wage-earners:	
Aggregate average number	581,728
Aggregate wages	$369,959,960
Above ground—	
Total average number	221,505
Total wages	$125,086,530
Engineers, firemen, and other mechanics—	
Average number	60,859
Wages	$44,478,246
Miners, or quarrymen and stonecutters—	
Average number	67,129
Wages	$33,971,290
Boys, under 16 years—	
Average number	6,219
Wages	$1,339,478
All other wage-earners—	
Average number	87,298
Wages	$45,297,516
Below ground—	
Total average number	360,223
Total wages	$244,873,430
Wage-earners—Continued:	
Miners—	
Average number	257,301
Wages	$184,674,193
Miners' helpers—	
Average number	18,736
Wages	$11,496,910
Boys, under 16 years—	
Average number	5,638
Wages	$1,548,889
All other wage-earners—	
Average number	78,548
Wages	$47,153,438
Contract work:	
Amount paid	$20,677,938
Number of employees	21,183
Miscellaneous expenses, total	$71,771,713
Royalties and rent of mine and mining plant	$34,530,713
Rent of offices, taxes, insurance, interest, and other sundries	$37,241,000
Cost of supplies and materials	$123,814,967
Product, value	$796,826,417
Power:	
Total horsepower	2,867,562
Owned—	
Engines—	
Steam, number	64,179
Horsepower	2,432,963
Gas, or gasoline, number	13,506
Horsepower	259,695
Water wheels, number	980
Horsepower	60,897
Other power, number	1,162
Horsepower	84,546
Rented—	
Electric, horsepower	23,556
Other kind, horsepower	5,905
Electric motors owned, number	2,893
Horsepower	130,494
Supplied to other establishments, horsepower	2,852

* Foremen here reported should be added to the number of wage-earners below ground in order to ascertain the actual number employed below ground.—Census Bulletin.

CLAY PRODUCTS OF THE UNITED STATES IN 1902.

In 1902 there were produced 8,475,067 thousands of common brick. The value of this product was $48,885,869, and the average price per thousand was $5.77. The quantity of front brick produced was 458,391 thousands, valued at $5,318,008. The average price per thousand was $11.60. Of vitrified paving brick the amount produced was 617,192 thousands, valued at $5,744,530, the average price per thousand being $9.31. The value of fancy or ornamental brick was $806,453. The value of fire brick was $11,970.511. The value of stove lining was $630.924. The value of drain tile was $3,506.787. The value of sewer pipe was $7,174,892. The value of ornamental terra cotta was $3,526,906. The value of the clay products used in fire-proofing was $3,175,593. The value of tile other than drain tile was $3,622,863. The value of adobes, aquarium ornaments, boiler and locomotive brick and tile, burnt-clay ballast, carboy stoppers, chemical brick and tile; chimney blocks, pipe and tops; clay furnaces, retorts, and settings; conduits for underground wires, crucibles, curbing block, fire-clay insulators, fire mortar, flue lining, furnace brick and tile, gas logs, glasshouse supplies, grave markers, ground fire brick, muffles, oven tile, paving block, porous cups, saggers, stone pumps, wall coping, web tile sewer, and well brick was $3,678,742. The value of the pottery produced was $24,127,453. making a grand total of all clay products of $122,169,531.—U. S. Geological Survey.

PETROLEUM, CRUDE, QUANTITIES OF, PRODUCED, IMPORTED, EXPORTED, AND RETAINED FOR CONSUMPTION.

Year Ending June 30—	Production.[1]	Net Imports.	Total.	Domestic Exports.			Remaining for Consumption.	Per Cent of Product Exported.
				Crude.	Illuminating Reduced to Crude.	Total.		
	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	
1880.	836,394,132	. . . .	836,394,132	28,297,997	483,323,451	511,621,448	324,772,684	61.17
1890.	1,476,867,546	721,932	1,477,589,478	95,450,653	688,546,171	783,996,824	693,592,654	53.09
1900.	2,396,975,700	[2] 17,540	2,396,993,240	133,023,656	948,720,575	1,081,744,231	1,315,249,009	45.13
1903.	3,728,210,472	[2] 270	3,728,210,742	134,892,170	920,798,950	1,055,691,120	2,672,519,622	28.32

[1] The production is of the calendar year preceding the fiscal year.
[2] Imports for consumption.

—Production furnished by Office of United States Geological Survey.

PRODUCTION OF GAS.

The total quantity of gas sold for lighting and heating, as reported to the Census in 1900 by 877 gas establishments from which returns were received, was 67,093,553,471 cubic feet. The total quantity of gas manufactured by companies as a by-product and disposed of was 1,171,942,697 cubic feet. A combination of this latter quantity with the quantity reported for gas companies shows that, in 1900, the total quantity sold was 68,265,496,168 cubic feet.

The price per 1,000 cubic feet varied from \$0.832 in Pennsylvania to \$4.50 in Nevada. Proximity to the coal and oil-producing districts gives to Pennsylvania the minimum average rate, while distance from source of supplies and limited transportation facilities are accountable for the high price in Nevada. These averages represent the price of all manufactured gas, both fuel and illuminating, as the quantity of each kind was not separately reported; this statement is necessary in order to obviate erroneous deductions. Idaho, Indian Territory, and Oklahoma have no gas plants.

The quantity of gas sold in New York city was 18,180,821,125 cubic feet, at an average price of \$0.905 per 1,000, or \$16,457,822 in the aggregate.

DIMENSIONS OF THE EARTH.

According to Bessel, in the metric system.

Equatorial radius (large axis, one half), $a = 6{,}377{,}397.15$ m.

Polar radius (small axis, one half), $b = 6{,}356{,}078.96$ m.

Oblateness,

$$p = \frac{a-b}{a} = \frac{1}{299.1528} = 0.0033427731.$$

Eccentricity of the meridians of the earth,

$$e = \sqrt{\frac{a^2-b^2}{a^2}} = 0.08169683.$$

A meridian-degree at the equator = 110,563.68 m.

A meridian-degree at the pole = 111,679.90 m.

A degree of the equator = 111,306.58 m.

Meridian quadrant = 10,000,855.76 m.

A geographic mile = 1-15 degree of the equator = 7,420.4385 m.

Radius of the sphere having the same surface as the earth = 6,370,289.5 m.

Radius of the sphere having the same capacity as the earth = 6,370,283.2 m.

Area of the earth = 509,950,714 qkm.

Cubic contents of the earth = 1,082,841,320,000 ckm.

Gravity at the level of the sea for the geographical latitude ϕ, $g = 9.7810m + 0.0503m \sin^2 \phi$.

Length of the seconds pendulum at the sea-level for the geographical latitude ϕ, $l = 0.99102m + 0.00510m \sin^2 \phi$.

Barbed Wire.—A pound of barbed wire should measure 16½ feet, and an acre of ground will require 50¾ lb. per line of fencing.

CHAPTER XV.

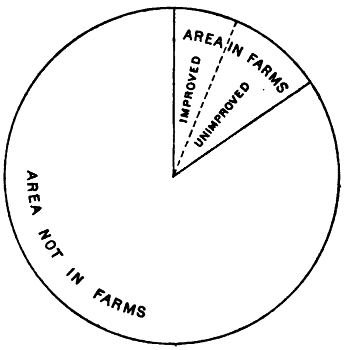
FARMS AND FOOD.

DIVISION OF THE UNITED STATES AS TO LAND.

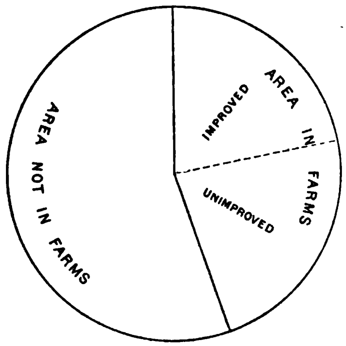
Farms.—According to the Census of 1900 there are 5,737,372 farms having 414,498,487 acres of improved land and 424,093,287 acres of unimproved land. The value of all farm property was $20,439,901,164. The value of the land with improvements, including buildings, was $16,614,647,491. The value of implements and machinery was $749,775,970. The value of the live stock was $3,075,477,703. The average number of acres to a farm was 146.2 acres.

The total value of the product of all the farms was $4,717,069,973, and was divided as follows: Animal products, $1,718,365,561; crops, $2,998,704,612. Of the latter, $974,940,616 was fed to the live stock. The value of all live stock on farms and ranges was $2,979,197,586; poultry, $85,756,503; bees, $10,178,087.

1850



1900



THE POULTRY INDUSTRY.

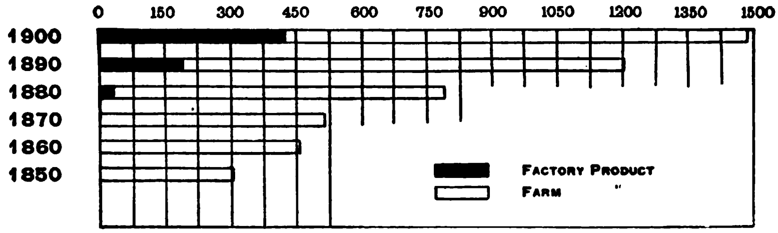
Chickens form an essential part of the stock upon many farms. The Twelfth Census shows that there were 5,737,372 farms in the United States in 1900, and it is safe to say that those which did not have chickens among the stock were very few indeed. The Census also shows that there were 250,681,593 fowls (chickens, turkeys, geese, and ducks) in the United States. This gives an average of forty-two to every farm. The value of all fowls on farms in 1900 was $85,794,996, producing for market in one year poultry worth $136,891.877 and eggs worth $144,286,370, a total value of $281,178,547. The investment has yielded an income of 40 per cent. In seeking for the cause of the great success attending poultry raising, one must not overlook the great amount of work done by the mechanical incubator, which is not only as fully successful as the hen, but works on a large scale.

DAIRY FARMS.

The Twelfth Census reports that in the year 1900 there were 5,737 372 farms in the United States, and of these 4,514,210 had dairy cows. Where a farm was found upon which at least 40 per cent. of the value of annual products was from dairy products, it was classified as a dairy farm. The total quantity of milk produced on farms in this country, during the year 1899, was 7,266,392,674 gallons, or, in round numbers, 62,500,000,000 pounds.

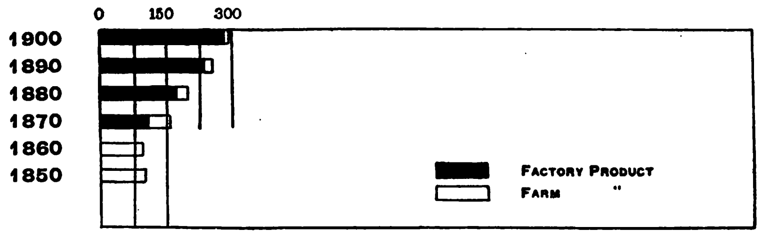
PRODUCTION OF BUTTER

in hundreds of millions of pounds.



PRODUCTION OF CHEESE

in hundreds of millions, of pounds.



MINERAL CONSTITUENTS ABSORBED OR REMOVED FROM AN ACRE OF SOIL BY THE FOLLOWING CROPS:

Minerals.	Wheat, 25 Bushels.	Barley, 40 Bushels.	Turnips, 20 Tons.	Hay, 1½ Tons.
	Lbs.	Lbs.	Lbs.	Lbs.
Potassium	29.6	17.5	47.1	38.2
Sodium.	3.	5.2	8.2	12.
Lime	12.9	17.	29.9	44.5
Magnesium	10.6	9.2	19.7	7.1
Oxide of Iron	2.6	2.1	7.1	.6
Phosphoric Acid	20.6	25.8	46.3	15 1
Sulphuric Acid	10.6	2.7	13.3	9.2
Chlorine	2.	16.	3.6	4.1
Silicium	118.1	129.5	247.8	78.2
Aluminum	....	2.4	....	....
Total	210.00	213.00	423.00	209.00

NUMBER AND VALUE OF DOMESTIC ANIMALS: 1900.

Domestic Animals.	Age in Years.	Total.		On Farms and Ranges.		Not on Farms or Ranges.	
		Number.	Value.	Number.	Value.	Number.	Estimated Value.
			Dollars.		Dollars.		Dollars.
All domestic animals.	....	....	3,193,856,459	....	2,979,197,586	......	214,658,873
All neat cattle. . .	....	69,335,832	1,516,307,270	67,719,410	1,475,204,633	1,616,422	41,102,637
Calves.	Under 1. .	15,577,728	139,638,829	15,315,582	137,290,001	262,146	2,348,828
Steers.	1 & und'r 2	7,008,656	131,392,522	6,953,113	130,352,202	55,543	1,040,320
Steers.	2 & und'r 3	5,244,011	152,871,930	5,193,006	151,386,664	51,005	1,485,266
Steers.	3 and over	3,179,069	113,123,532	3,073,267	109,366,503	105,802	3,757,029
Bulls.	1 and over	1,328,741	45,831,378	1,315,132	45,362,004	13,609	469,374
Heifers.	1 & und'r 2	7,254,000	122,874,299	7,174,483	121,528,076	79,517	1,346,223
Cows kept for milk.	2 and over	18,108,666	537,496,120	17,135,633	508,616,501	973,033	28,879,619
Cows not kept for milk. . . .	2 and over	11,634,961	273,078,660	11,559,194	271,302,682	75,767	1,775,978
All horses.	....	21,203,901	1,050,526,967	18,267,020	896,513,217	2,936,881	154,013,750
Colts.	Under 1. .	1,347,919	26,548,413	1,314,829	25,896,871	33,090	651,542
Horses.	1 & und'r 2	1,476,627	49,313,762	1,446,225	48,298,639	30,402	1,015,123
Horses.	2 and over	18,379,355	974,664,792	15,505,966	822,317,707	2,873,389	152,347,085
All mules.	....	3,438,523	207,274,557	3,264,615	196,222,053	173,908	11,052,504
Mule colts. . . .	Under 1. .	234,784	6,286,385	231,628	6,201,899	3,156	84,486
Mules.	1 & und'r 2	283,829	11,937,495	279,501	11,755,416	4,328	182,079
Mules.	2 and over	2,919,910	189,050,677	2,753,486	178,264,738	166,424	10,785,939
Asses and burros	All ages. .	110,012	6,776,583	94,165	5,811,184	15,847	965,399
All sheep.	....	61,735,014	170,881,743	61,503,713	170,203,119	231,301	678,624
Lambs.	Under 1 . .	21,702,447	42,116,628	21,650,746	42,016,328	51,701	100,300
Sheep (ewes) .	1 and over	31,997,274	101,732,728	31,857,652	101,288,730	139,622	443,998
Sheep (rams and wethers).	1 and over	8,035,293	27,032,387	7,995,315	26,898,061	39,978	134,326
Swine.	All ages	64,686,155	238,686,872	62,868,041	231,978,031	1,818,114	6,708,841
Goats.	All ages	1,948,952	3,402,467	1,870,599	3,265,349	78,353	137,118

—From Reports of the Census.

QUANTITY AND VALUE OF ANIMAL PRODUCTS OF FARMS: 1899.

Product.	Unit of Measure.	Quantity.	Value.
Total.	....	....	$1,718,365,561
Wool.	Pound	276,567,584	$45,670,053
Mohair and goat hair.	do.	961,328	267,864
Milk.	Gallon	[1] 7,265,804,304	472,276,783 (Milk, Butter, Cheese)
Butter.	Pound	1,071,626,056	
Cheese.	do.	16,372,318	
Eggs.	Dozen	1,293,662,433	144,240,541
Poultry.	....	....	136,830,152
Honey.	Pound	61,099,290	6,656,611 (Honey, Wax)
Wax.	do.	1,763,595	
Animals sold.	....	....	722,614,328
Animals slaughtered.	....	....	189,809,229

[1] Includes all milk produced.

—From Reports of the Census.

ACREAGE, QUANTITY, AND VALUE OF FARM CROPS IN 1899.

From Reports of the Census.

Crop.	Acres.	Unit of Measure.	Quantity.	Value.
Total..	....	....	....	$2,998,704,412
Corn.	94,913,673	Bushel	2,666,324,370	$828,192,388
Wheat.	52,588,574	do.	658,534,252	369,945,320
Oats.	29,539,698	do.	943,389,375	217,098,584
Barley.	4,470,196	do.	119,634,877	41,631,762
Rye.	2,054,292	do.	25,568,625	12,290,540
Buckwheat.	807,060	do.	11,233,515	5,747,853
Broom corn.	178,584	Pound	90,947,370	3,588,414
Rice.	342,214	do.	250,280,227	6,329,562
Kaffir corn	266,513	Bushel	5,169,113	1,367,040
Flaxseed.	2,110,517	do.	19,979,492	19,624,901
Clover seed.	....	do.	1,349,209	5,359,578
Grass seed.	....	do.	3,515,869	2,868,839
Hay and forage.	61,691,069	Ton	84,010,915	484,254,703
Cottonseed.	....	do.	[1] 4,566,100	46,950,575
Cotton.	24,275,101	Bale	9,534,707	323,758,171
Tobacco.	1,101,460	Pound	868,112,865	56,987,902
Hemp.	16,042	do.	11,750,630	546,338
Honey	....	do.	61,196,160	....
Hops.	55,613	do.	49,209,704	4,081,929
Peanuts.	516,654	Bushel	11,964,109	7,270,515
Peppermint.	8,591	Pound	187,427	143,618
Dry beans.	453,841	Bushel	5,064,490	7,633,636
Castor beans.	25,738	do.	143,388	134,084
Dry pease.	968,370	do.	9,440,210	7,908,966
Potatoes.	2,938,778	do.	273,318,167	98,380,110
Sweet potatoes.	537,312	do.	42,517,412	19,869,840
Onions.	47,981	do.	11,790,974	6,637,413
Chicory.	3,069	Pound	21,495,870	73,627
Milk.	....	Gallons	7,266,392,674	....
Miscellaneous vegetables.	2,114,149	....	....	113,644,398
Maple sugar.	....	Pound	11,928,770	1,074,260
Maple sirup.	....	Gallon	2,056,611	1,562,451
Sugar-cane.	386,986	Ton	[2] 4,202,202	....
(*a*) Cane sold.	....	do.	1,126,076	3,881,758
(*b*) Cane kept for seed.	....	do.	1,453,447	5,018,469
(*c*) Sugar made.	....	Pound	159,454,814	6,558,944
(*d*) Molasses made.	....	Gallon	6,312,809	788,990
(*e*) Sirup made.	....	do.	12,293,032	4,293,475
Sorghum cane.	293,152	Ton	[3] 291,703	815,019
Sorghum sirup.	....	Gallon	16,972,783	5,288,083
Sugar beets.	110,170	Ton	793,353	3,323, 40
Small fruits.	309,770	....	....	25,029,757
Grapes.	....	Cental	13,009,841	[4] 14,090,234
Orchard products.	....	Bushel	212,365,600	[5] 83,750,961
Subtropical fruits.	....	....	....	8,227,838
Nuts.	....	....	....	1,949,931
Forest products.	....	....	....	109,864,774
Flowers and plants.	9,307	....	....	18,758,864
Miscellaneous seeds.	10,106	....	....	826,019
Nursery products.	59,492	....	....	10,123,873
Willows.	521	....	....	36,523
Miscellaneous.	23,793	....	....	[6] 1,120,343

[1] Not including 166,861 tons sold with fiber before ginning.

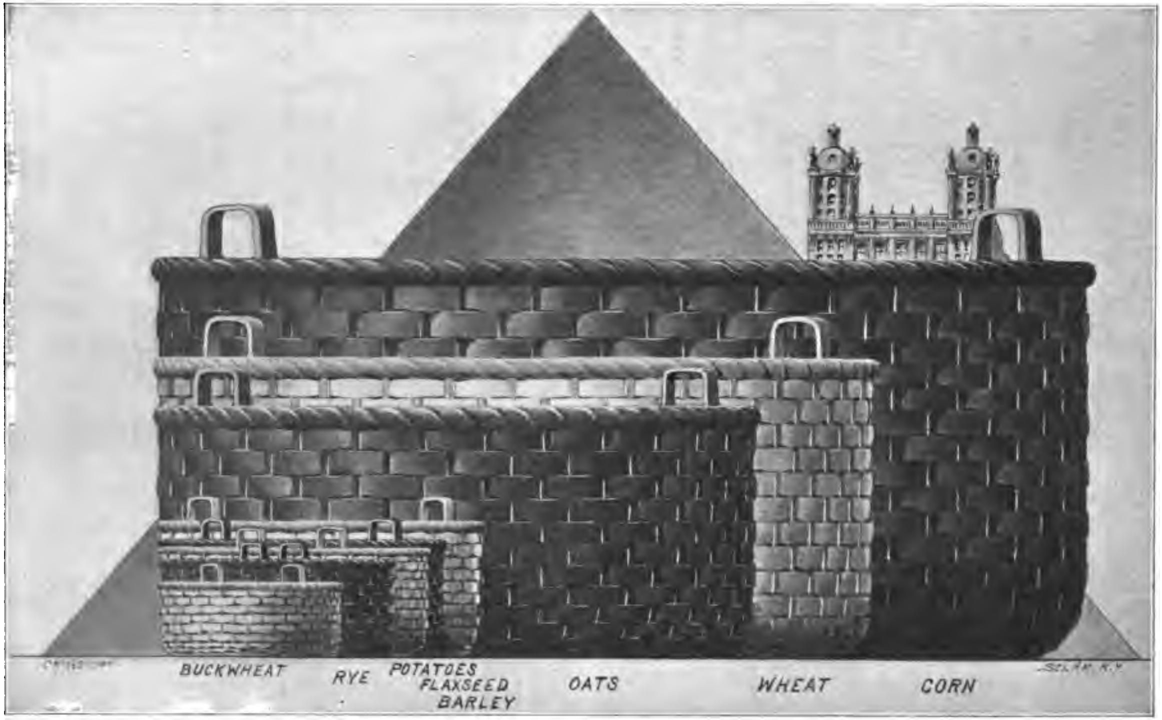
[2] Comprising all cane grown, whether sold as cane, kept for seed, or used in the manufacture of sugar, molasses, and sirup.

[3] Sold as cane.

[4] Including value of raisins, wine, etc.

[5] Including value of cider, vinegar, etc.

[6] The greater part of this value was derived from products for which no acreage was reported.



COMPARISON OF PRINCIPAL CROPS OF THE UNITED STATES.

FRUIT PRODUCTS.

(Abstracted from the United States Census Reports.)

Product.	Unit of Measure.	Quantity.	Value.
Fruits (orchard)	Bushels	212,366,646	$83,751,840
Apples	Bushels	175,397,626	....
Apricots	Bushels	2,642,128	....
Cherries	Bushels	2,873,499	....
Peaches, etc.	Bushels	15,433,623	....
Pears	Bushels	6,625,417	....
Plums, etc.	Bushels	8,764,032	....
Unclassified	Bushels	630,321	....
Cider	Barrels	1,754,927	....
Cider vinegar	Barrels	392,497	....
Fruits (small)	Quarts	431,628,520	25,030,877
Blackberries	Quarts	62,189,885	....
Currants	Quarts	18,592,695	....
Gooseberries	Quarts	9,320,530	....
Raspberries	Quarts	76,628,107	....
Strawberries	Quarts	257,437,523	....
Unclassified	Quarts	7,459,780	....
Fruits (sub-tropical)	....	....	8,549,863
Bananas	Bunches	141,653	....
Citrons	Boxes	90	....
Figs	Pounds	13,016,274	....
Guava	Pounds	1,677,165	....
Lemons	Boxes	876,978	....
Limes	Boxes	24,375	....
Olives	Pounds	5,053,637	....
Oranges	Boxes	6,171,259	....
Persimmons	Pounds	136,030	....
Pineapples	....	2,980,240	....
Pomeloes	Boxes	30,791	....
Unclassified	Pounds	2,969,239	....
Olive oil	Gallons	8,643	....
Coffee	Pounds	2,297,000	246,181

STATISTICS OF PRINCIPAL CROPS.

Crop.	Year.	Acreage.	Unit.	Average Yield per Acre.	Production.
Corn	1903	88,091,993	Bushel	25.5	2,244,176,925
Wheat	1903	49,464,967	"	12.9	637,821,835
Oats	1903	27,638,126	"	28.4	784,094,199
Barley	1903	4,993,137	"	26.4	131,861,391
Rye	1903	1,906,894	"	15.4	29,363,416
Buckwheat	1903	804,393	"	17.7	14,243,644
Potatoes	1903	2,916,855	"	84.7	247,127,880
Hay	1903	39,933,759	Ton	1.54	61,305,940
Cotton	1902–1903	27,114,103	Bale	....	10,725,422
Tobacco	1903	1,037,735	Pound	786.3	815,972,425
Flaxseed	1903	3,233,239	Bushel	8.4	27,300,510
Sugar, beet and cane	1903–1904	....	Long ton	....	423,135

STATISTICS OF PRINCIPAL CROPS—*Continued.*

Crop.	Year.	Unit.	Average Farm Price.	Farm Value.	Exports, Bushels.[1]
Corn	1903	Bushel	42.5 c.	$952,868,801	76,639,261
Wheat	1903	"	69.5 c.	443,024,826	202,906,273
Oats	1903	"	34.1 c.	267,661,665	8,381,805
Barley	1903	"	45.6 c.	60,166,313	56,462
Rye	1903	"	54.5 c.	15,993,871	5,445,273
Buckwheat	1903	"	60.7 c.	8,650,733	....
Potatoes	1903	"	61.4 c.	15,638,094	843,075
Hay	1903	Ton	$9.08	556,376,880	[2] 50,974
Cotton	1902–1903	Bale	....	458,051,005	[3] 7,086,086
Tobacco	1903	Pound	6.8 c.	55,514,627	....
Flaxseed	1903	Bushel	81.7 c.	22,291,557	....
Sugar, beet and cane	1903–1904	Long ton	....	....	....

[1] Does not necessarily mean the crop year; in all cases one year and generally two years behind.
[2] Tons instead of bushels.
[3] 1902–1903.

STATISTICS OF PRINCIPAL ANIMALS.

Animals.	Year.	Number.	Value.
Horses	1904	16,736,059	$1,136,940,298
Mules	1904	2,757,916	217,532,916
Cows	1904	17,419,817	508,841,489
Other cattle	1904	43,629,438	712,178,134
Sheep	1904	51,630,144	133,530,099
Hogs	1904	47,009,367	289,224,627

CUTS OF MEAT.

The method of dividing up the carcasses of slaughtered animals varies considerably in different localities. In order that there may be no confusion on this account the character of the cuts of beef, veal, pork and mutton is shown in the diagrams given on page 362.

THE FUNCTIONS AND USES OF FOODS.

BY C. F. LANGWORTHY, PH. D.

Office of Experiment Stations.

In this article a number of the terms used in discussing food are defined and some of the principles of nutrition are briefly stated. The average composition of a number of the more common American foods is quoted as well as the commonly accepted dietary standards. With the aid of such data, the nutritive value of any given diet may be computed and its comparative value ascertained.

Ordinary food materials, such as meat, fish, eggs, potatoes, wheat, etc., consist of:

Refuse.—As the bones of meat and fish, shells of shellfish, skins of potatoes, bran of wheat, etc.

Edible Portion.—As the flesh of meat and fish, the white and yolk of eggs, wheat flour, etc. The edible portion consists of water and nutritive ingredients, or nutrients. The nutritive ingredients are ***protein, fats, carbohydrates*** and ***mineral matters.***

The water, refuse, and salt of salted meat and fish are called non-nutrients. In comparing the values of different food materials for nourishment they are left out of account.

USE OF NUTRIENTS.

Food is used in the body to build and repair tissue and to furnish energy. The manner in which the valuable constituents are utilized in the body may be expressed in tabular form as follows:

Protein. White (albumen) of eggs, curd (casein) of milk, lean meat, gluten of wheat, etc.	Forms tissue (muscles, tendon, and probably fat).	All serve as *fuel* and yield *energy* in form of heat and muscular strength.
Fats. Fat of meat, butter, olive oil, oils of corn and wheat, etc.	Form fatty tissue.	
Carbohydrates. Sugar, starch, etc.	Transformed into fat.	
Mineral matters (ash). Phosphates of lime, potash, soda, etc.	Aid in forming bone, assist in digestion, etc.	

The Fuel Value of Food.—Heat and muscular power are forms of force or energy. The energy is developed as the food is consumed in the body. The unit commonly used in this measurement is the calorie, the amount of heat which would raise the temperature of a pound of water 4 deg. Fahrenheit.

Instead of this unit some unit of mechanical energy might be used—for

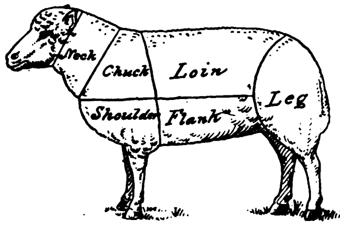


DIAGRAM OF CUTS OF MUTTON.

instance, the foot-ton, which represents the force required to raise one ton one foot. One calorie is equal to very nearly 1.53 foot-tons.

The following general estimate has been made for the average amount of potential energy in 1 pound of each of the classes of nutrients:

	Calories.
In 1 pound of protein........	1,860
In 1 pound of fats...........	4,220
In 1 pound of carbohydrates..	1,860

In other words, when we compare the nutrients in respect to their fuel values, their capacities for yielding heat and mechanical power,

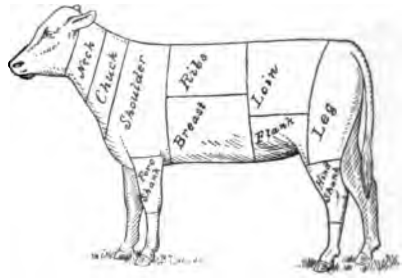


DIAGRAM OF CUTS OF VEAL.

a pound of protein of lean meat or albumen of egg is just about equivalent to a pound of sugar or starch, and a little over two pounds of either would

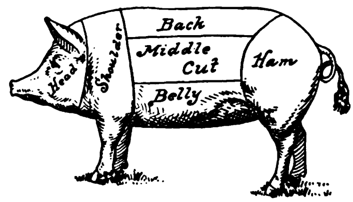


DIAGRAM OF CUTS OF PORK.

be required to equal a pound of the fat of meat or butter or the body fat.

Within recent years analyses of a large number of samples of foods have been made in this country. In the tables on pages 364-367 the results of a number of these analyses are given:

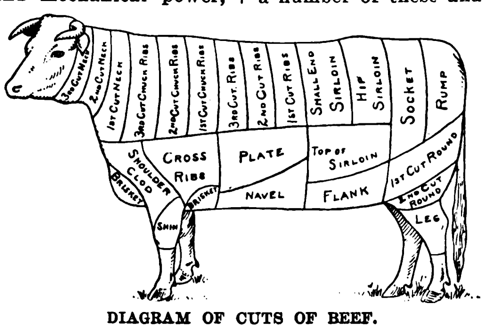


DIAGRAM OF CUTS OF BEEF.

COMPARISON OF FARM ANIMALS IN THE UNITED STATES.

AVERAGE COMPOSITION OF AMERICAN FOOD PRODUCTS.

Food Materials (as purchased).	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel Value per Lb.
ANIMAL FOOD.							Calories.
Beef, fresh:	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	
Chuck, including shoulder	17.3	54.0	15.8	12.5	......	0.7	820
Chuck ribs	19.1	53.8	15.3	11.1	......	.8	755
Flank	5.5	56.1	18.6	19.9	......	.8	1,185
Loin	13.3	52.9	16.4	16.9	......	.9	1,020
Porterhouse steak	12.7	52.4	19.1	17.9	......	.8	1,110
Sirloin steak	12.8	54.0	16.5	16.1	......	.9	985
Neck	31.2	45.3	14.2	9.2	......	.7	650
Ribs	20.1	45.3	14.4	20.0	......	.7	1,110
Rib rolls	......	64.8	19.4	15.5	......	.9	1,015
Round	8.5	62.5	19.2	9.2	......	1.0	745
Rump	19.0	46.9	15.2	18.6	......	.8	1,065
Shank, fore	38.3	43.2	13.2	5.2	......	.6	465
Shoulder and clod	17.4	57.0	16.5	8.4	......	.9	660
Fore quarter	20.6	49.5	14.4	15.1	......	.7	905
Hind quarter	16.3	52.0	16.1	15.4	......	.8	950
Beef, corned, canned, pickled, and dried:							
Corned beef	8.4	49.2	14.3	23.8	......	4.6	1,271
Tongue, pickled	6.0	58.9	11.9	19.2	......	4.3	1,030
Dried, salted, and smoked	4.7	53.7	26.4	6.9	......	8.9	780
Canned boiled beef	......	51.8	25.5	22.5	......	1.3	1,425
Canned corned beef	......	51.8	26.3	18.7	......	4.0	1,280
Veal:							
Breast	23.3	52.5	15.7	8.2	......	.8	635
Leg	11.7	63.4	18.3	5.8	......	1.0	585
Leg cutlets	3.4	68.3	20.1	7.5	......	1.0	690
Fore quarter	24.5	54.2	15.1	6.0	......	.7	535
Hind quarter	20.7	56.2	16.2	6.6	......	.8	580
Mutton:							
Flank	9.9	39.0	13.8	36.9	......	.6	1,815
Leg, hind	17.7	51.9	15.4	14.5	......	.8	900
Shoulder	22.1	46.8	13.7	17.1	......	.7	975
Fore quarter	21.2	41.6	12.3	24.5	......	.7	1,265
Hind quarter, without tallow	19.3	43.3	13.0	24.0	......	.7	1,255
Lamb:							
Breast	19.1	45.5	15.4	19.1	......	.8	1,090
Leg, hind	13.8	50.3	16.0	19.7	......	.9	1,130
Pork, fresh:							
Flank	18.0	48.5	15.1	18.6	......	.7	1,065
Ham	10.3	45.1	14.3	29.7	......	.8	1,520
Loin chops	19.3	40.8	13.2	26.0	......	.8	1,340
Shoulder	12.4	44.9	12.0	29.8	......	.7	1,480
Tenderloin	......	66.5	18.9	13.0	......	1.0	900
Pork, salted, cured, and pickled:							
Ham, smoked	12.2	35.8	14.5	33.2	......	4.2	1,670
Shoulder, smoked	18.9	30.7	12.6	33.0	......	5.0	1,625
Salt pork	......	7.9	1.9	86.2	......	3.9	3,670
Bacon, smoked	8.7	18.4	9.5	59.4	......	4.5	2,685
Sausage:							
Bologna	3.3	55.2	18.2	19.7	......	3.8	1,170
Farmer	3.9	22.2	27.9	40.4	......	7.3	2,225
Frankfort	......	57.2	19.6	18.6	1.1	3.4	1,170
Soups:							
Celery, cream of	......	88.6	2.1	2.8	5.0	1.5	250
Beef	......	92.9	4.4	.4	1.1	1.2	120
Meat stew	......	84.5	4.6	4.3	5.5	1.1	370
Tomato	......	90.0	1.8	1.1	5.6	1.5	185
Poultry:							
Chicken, broilers	41.6	43.7	12.8	1.4	......	.7	295
Fowls	25.9	47.1	13.7	12.3	......	.7	775
Goose	17.6	38.5	13.4	29.8	......	.7	1,505
Turkey	22.7	42.4	16.1	18.4	......	.8	1,075
Fish:							
Cod, dressed	29.9	58.5	11.1	.2	......	.8	215
Halibut, steaks or sections	17.7	61.9	15.3	4.4	......	.9	470
Mackerel, whole	44.7	40.4	10.2	4.2	......	.7	365
Perch, yellow, dressed	35.1	50.7	12.8	.7	......	.9	265
Shad, whole	50.1	35.2	9.4	4.8	......	.7	380
Shad, roe	......	71.2	20.9	3.8	2.6	1.5	600
Fish, salt: Cod	24.9	40.2	19.0	.4	......	18.5	315

AVERAGE COMPOSITION OF AMERICAN FOOD PRODUCTS—*Continued.*

Food Materials (as purchased).	Refuse.	Water.	Protein.	Fat.	Carbohydrates.	Ash.	Fuel Value per Lb.
Fish, canned:	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Calories.
Salmon	14.2	56.8	19.5	7.5	......	2.0	680
Sardines	[1] 5.0	53.6	23.7	12.1	......	5.3	950
Shellfish:							
Oysters, "solids"	......	88.3	6.0	1.3	3.3	1.1	230
Clams	......	80.8	10.6	1.1	5.2	2.3	340
Crabs	52.4	36.7	7.9	.9	.6	1.5	195
Lobsters	61.7	30.7	5.9	.7	.2	.8	140
Eggs: Hens' eggs	[2] 11.2	65.5	11.9	9.3	......	.9	635
Dairy products, etc.:							
Butter	......	11.0	1.0	85.0	......	3.0	3,605
Whole milk	......	87.0	3.3	4.0	5.0	.7	325
Skim milk	......	90.5	3.4	.3	5.1	.7	170
Buttermilk	......	91.0	3.0	.5	4.8	.7	165
Condensed milk	......	26.9	8.8	8.3	54.1	1.9	1,520
Cream	......	74.0	2.5	18.5	4.5	.5	910
Cheese, Cheddar	......	27.4	27.7	36.8	4.1	4.0	2,145
Cheese, full cream	......	34.2	25.9	33.7	2.4	3.8	1,950
VEGETABLE FOOD.							
Flour, meal, etc.:							
Entire-wheat flour	......	11.4	13.8	1.9	71.9	1.0	1,675
Graham flour	......	11.3	13.3	2.2	71.4	1.8	1,670
Wheat flour, patent roller process—							
High-grade and medium	......	12.0	11.4	1.0	75.1	.5	1,650
Low grade	......	12.0	14.0	1.9	71.2	.9	1,665
Macaroni	......	78.4	3.0	1.5	15.8	1.3	415
Crushed wheat	......	10.1	11.1	1.7	75.5	1.6	1,685
Buckwheat flour	......	13.6	6.4	1.2	77.9	.9	1,620
Corn meal	......	12.5	9.2	1.9	75.4	1.0	1,655
Oatmeal	......	7.3	16.1	7.2	67.5	1.9	1,860
Rice	......	12.3	8.0	.3	79.0	.4	1,630
Tapioca	......	11.4	.4	.1	88.0	.1	1,650
Starch	......	......	......	......	90.0	......	1,675
Bread, pastry, etc.:							
White bread	......	35.3	9.2	1.3	53.1	1.1	1,215
Brown bread	......	43.6	5.4	1.8	47.1	2.1	1,050
Graham bread	......	35.7	8.9	1.8	52.1	1.5	1,210
Whole-wheat bread	......	38.4	9.7	.9	49.7	1.3	1,140
Rye bread	......	35.7	9.0	.6	53.2	1.5	1,180
Cake	......	19.9	6.3	9.0	63.3	1.5	1,675
Cream crackers	......	6.8	9.7	12.1	69.7	1.7	1,990
Oyster crackers	......	4.8	11.3	10.5	70.5	2.9	1,965
Soda crackers	......	5.9	9.8	9.1	73.1	2.1	1,925
Sugars, etc.:							
Molasses	......	25.1	2.4	......	69.3	3.2	1.290
Candy	......	......	......	......	96.0	......	1,785
Honey [3]	......	18.2	.4	......	81.2	.2	1,520
Sugar, granulated	......	......	......	......	100.0	......	1,800
Maple sirup	......	......	......	......	71.4	......	1,330
Vegetables:[4]							
Beans, dried	......	12.6	22.5	1.8	59.6	3.5	1,605
Beans, Lima, shelled	......	68.5	7.1	.7	22.0	1.7	570
Beans, string	7.0	83.0	2.1	.3	6.9	.7	180
Beets	20.0	70.0	1.3	.1	7.7	.9	170
Cabbage	15.0	77.7	1.4	.2	4.8	.9	125
Celery	20.0	75.6	.9	.1	2.6	.8	70
Corn, green (sweet), edible portion	......	75.4	3.1	1.1	19.7	.7	470
Cucumbers	15.0	81.1	.7	.2	2.6	.4	70
Lettuce	15.0	80.5	1.0	.2	2.5	.8	75
Mushrooms	......	88.1	3.5	.4	6.8	1.2	210
Onions	10.0	78.9	1.4	.3	8.9	.5	205
Parsnips	20.0	66.4	1.3	.4	10.8	1.1	240
Peas (*Pisum sativum*), dried	......	9.5	24.6	1.0	62.0	2.9	1,655

[1] Refuse, oil. [2] Refuse, shell.

[3] Contained on an average cane sugar 2.8 and reducing sugar 71.1 per cent. The reducing sugar was composed of about equal amounts of glucose (dextrose) and fruit sugar (levulose).

[4] Such vegetables as potatoes, squash, beets, etc., have a certain amount of inedible material, skin, seeds, etc. The amount varies with the method of preparing the vegetables, and cannot be accurately estimated. The figures given for refuse of vegetables, fruits, etc., are assumed to represent approximately the amount of refuse in these foods as ordinarily prepared.

AVERAGE COMPOSITION OF AMERICAN FOOD PRODUCTS—*Continued.*

Food Materials (as purchased).	Ref-use.	Water.	Pro-tein.	Fat.	Car-bohy-drates.	Ash.	Fuel Value per Lb.
Vegetables—(*Continued*):	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Per Ct.	Calo-ries.
Peas (*Pisum sativum*), shelled	......	74.6	7.0	0.5	16.9	1.0	465
Cowpeas, dried	......	13.0	21.4	1.4	60.8	3.4	1,590
Potatoes	20.0	62.6	1.8	.1	14.7	.8	310
Rhubarb	40.0	56.6	.4	.4	2.2	.4	65
Sweet potatoes	20.0	55.2	1.4	.6	21.9	.9	640
Spinach	......	92.3	2.1	.3	3.2	2.1	110
Squash	50.0	44.2	.7	.2	4.5	.4	105
Tomatoes	......	94.3	.9	.4	3.9	.5	105
Turnips	30.0	62.7	.9	.1	5.7	.6	125
Vegetables, canned:							
Peas (*Pisum sativum*), green	......	85.3	3.6	.2	9.8	1.1	255
Corn, green	......	76.1	2.8	1.2	19.0	.9	455
Tomatoes	......	94.0	1.2	.2	4.0	.6	105
Fruits, berries, etc., fresh:[1]							
Apples	25.0	63.3	.3	.3	10.8	.3	220
Bananas	35.0	48.9	.8	.4	14.3	.6	300
Grapes	25.0	58.0	1.0	1.2	14.4	.4	335
Lemons	30.0	62.5	.7	.5	5.9	.4	145
Muskmelons	50.0	44.8	.3	......	4.6	.3	90
Oranges	27.0	63.4	.6	.1	8.5	.4	170
Pears	10.0	76.0	.5	.4	12.7	.4	260
Persimmons, edible portion	......	66.1	.8	.7	31.5	.9	630
Raspberries	......	85.8	1.0	......	12.6	.6	255
Strawberries	5.0	85.9	.9	.6	7.0	.6	175
Watermelons	59.4	37.5	.2	.1	2.7	.1	60
Fruits, dried:							
Apples	......	28.1	1.6	2.2	66.1	2.0	1,350
Apricots	......	81.4	.9	......	17.3	.4	340
Dates	10.0	13.8	1.9	2.5	70.6	1.2	1,450
Figs	......	18.8	4.3	.3	74.2	2.4	1,475
Nuts:							
Almonds	45.0	2.7	11.5	30.2	9.5	1.1	1,660
Beechnuts	40.8	2.3	13.0	34.0	7.8	2.1	1,820
Brazil nuts	49.6	2.6	8.6	33.7	3.5	2.0	1,655
Butternuts	86.4	.6	3.8	8.3	.5	.4	430
Chestnuts, fresh	16.0	37.8	5.2	4.5	35.4	1.1	945
Chestnuts, dried	24.0	4.5	8.1	5.3	56.4	1.7	1,425
Cocoanuts	[2] 48.8	7.2	2.9	25.9	14.3	.9	1,413
Cocoanut, prepared	......	3.5	6.3	57.4	31.5	1.3	3,125
Filberts	52.1	1.8	7.5	31.3	6.2	1.1	1,575
Hickory nuts	62.2	1.4	5.8	25.5	4.3	.8	1,265
Pecans, polished	53.2	1.4	5.2	33.3	6.2	.7	1,620
Peanuts	24.5	6.9	19.5	29.1	18.5	1.5	1,935
Piñon (*Pinus edulis*)	40.6	2.0	8.7	36.8	10.2	1.7	1,905
Walnuts, California, black	74.1	.6	7.2	14.6	3.0	.5	805
Walnuts, California, soft-shell	58.1	1.0	6.9	26.6	6.8	.6	1,375
Raisins	10.0	13.1	2.3	3.0	68.5	3.1	1,455
Miscellaneous:							
Chocolate	......	5.9	12.9	48.7	30.3	2.2	2,860
Cocoa, powdered	......	4.6	21.6	28.9	37.7	7.2	2,320
Cereal coffee, infusion (1 part boiled in 20 parts water)[3]	......	98.2	.2	......	1.4	.2	30

[1] Fruits contain a certain proportion of inedible materials, as skin, seeds, etc., which are properly classed as refuse. In some fruits, as oranges and prunes, the amount rejected in eating is practically the same as refuse. In others, as apples and pears, more or less of the edible material is ordinarily rejected with the skin and seeds and other inedible portions. The edible material which is thus thrown away, and should properly be classed with the waste, is here classed with the refuse. The figures for refuse here given represent, as nearly as can be ascertained, the quantities ordinarily rejected.

[2] Milk and shell.

[3] The average of five analyses of cereal coffee grain is: Water 6.2, protein 13.3, fat 3.4, carbohydrates 72.6, and ash 4.5 per cent. Only a portion of the nutrients, however, enter into the infusion. The average in the table represents the available nutrients in the beverage Infusions of genuine coffee and of tea like the above contain practically no nutrients.

DIETARY STANDARDS.

Dietary studies have been made in considerable numbers in different countries. The results of such studies and experiments to determine the amount of food required by men engaged in different occupations have resulted in the adoption of dietary standards. Some of these follow:

STANDARDS FOR DAILY DIETARIES.

Character of Work to be Performed.	Nutrients.			Fuel. Value.
	Protein.	Fat.	Carbohydrates.	
European:	Pound.	Pound.	Pounds.	Calories.
Man at moderate work	0.26	0.12	1.10	3,055
Man at hard work	.32	.22	.99	3,370
American:				
Man without muscular work	.20	....	....	3,000
Man with light muscular work	.22	....	....	3,000
Man with moderate muscular work	.28	....	....	3,500
Man with hard muscular work	.39	....	....	4,500

The table of composition of food materials shows the amount of water, protein, fat, carbohydrates and ash content and the total fuel value per pound for each kind of food named. The protein, fat and carbohydrates all furnish energy. In addition to furnishing energy, protein forms tissue. Since protein and energy are the essential features of food, dietary standards may be expressed in their simplest form in terms of protein and energy alone.

Observation has shown that as a rule a woman requires less food than a man, and the amount required by children is still less, varying with the age. It is customary to assign certain factors which shall represent the amount of nutrients required by children of different ages and by women as compared with adult man. The various factors which have been adopted are as follows:

FACTORS USED IN CALCULATING MEALS CONSUMED IN DIETARY STUDIES.

One meal of woman equivalent to 0.8 meal of man at moderate muscular labor.

One meal of boy 14 to 16 years of age, inclusive, equivalent to 0.8 meal of man.

One meal of girl 14 to 16 years of age, inclusive, equivalent to 0.7 meal of man.

One meal of child 10 to 13 years of age, inclusive, equivalent to 0.6 meal of man.

One meal of child 6 to 9 years of age, inclusive, equivalent to 0.5 meal of man.

One meal of child 2 to 5 years of age, inclusive, equivalent to 0.4 meal of man.

One meal of child under 2 years of age equivalent to 0.3 meal of man.

These factors are based in part upon experimental data and in part upon arbitrary assumptions. They are subject to revision when experimental evidence shall warrant more definite conclusions.

The plan followed in making dietary studies is, briefly, as follows: Exact account is taken of all the food materials (1) at the beginning of the study, (2) purchased during its progress, and (3) remaining at the end. The difference between the third and the sum of the first and second is taken as representing the amount used. From the figures thus obtained for the total quantities of the different food materials the amounts of the different nutrients and the energy furnished by them are calculated. Deducting from these values the nutrients and energy found in the kitchen and table refuse, the amounts actually consumed are obtained. Account is also taken of the meals eaten by different members of the family or groups studied and by visitors, if there are any. From the total food eaten by all the persons during the entire period the amount eaten per man per day may be calculated. In making these calculations due account is taken of the fact that, as stated above, women and children eat less than men performing the same amount of work.

PRODUCTS OF THE FISHERIES OF THE UNITED STATES.

Specially prepared for the Scientific American Reference Book by the United States Fish Commission.

Species.	New England States, 1902.		Middle Atlantic States, 1901.		South Atlantic States, 1902.		Gulf States, 1902.		Pacific Coast States, 1899.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives	8,437,296	$89,283	34,479,005	$262,352	11,601,172	$118,258				
Barracuda					1,000	50	34,435	$1,203	1,191,505	$32,703
Black bass			233,378	19,780	948,235	70,524	84,730	5,865		
Bluefish	689,760	42,991	16,317,795	758,122	1,057,642	37,856	398,776	12,435		
Bonito	291,650	9,774	1,668,555	42,695	10,326	244	10,100	503	119,737	3,893
Buffalo-fish							3,006,610	26,556		
Butter-fish	543,958	17,489	5,129,543	149,984	83,218	1,357	3,140	46		
Catfish	489,968	4,355	2,063,584	77,396	1,310,392	30,976	2,415,315	72,991	625,971	15,935
Cod	87,628,949	2,176,787	3,475,012	119,590					6,847,131	201,304
Crappie and strawberry bass					223,606	5,226	29,900	1,928		
Croakers			4,501,894	64,201	1,991,053	40,021	543,810	19,326	40,919	1,123
Cusk	5,405,824	79,418								
Drum, fresh-water							5,550	131		
Drum, salt-water			343,152	4,201	583,394	14,453	3,026,756	90,260		
Eels	1,402,558	75,111	2,900,927	152,874	512,411	20,068				
Flatfish and flounders	4,535,746	130,057	3,231,039	111,755	315,642	6,783	438,741	17,959	4,726,827	92,646
German carp	2,134	164	1,159,958	59,238	96,509	3,616	1,175	33	283,514	2,400
Haddock	46,701,315	944,700	387,666	14,617						
Hake	32,600,559	332,680	407,429	6,500						
Halibut	12,360,705	662,538							6,877,640	192,580
Herring	189,916,967	905,460	180,000	2,025					2,080,137	20,850
Mackerel	20,358,982	1,136,754	519,643	21,211					153,666	6,415
Menhaden	18,469,390	56,401	493,936,462	987,228	18,862,000	31,420	12,500	50		
Mullet			325,459	13,465	14,310,808	256,348	27,098,435	442,536	22,000	610
Paddlefish										
Perch, white	82,335	4,740	2,752,649	154,239	945,050	62,786				
Perch, yellow	450	30	495,346	17,203	105,992	5,639				
Pike perch			14,675	2,321						
Pike and pickerel	8,230	530	120,553	9,287	31,200	1,505	58,975	2,338	16,005	639
Pollock	17,702,127	169,199	42,581	1,240						
Pompano			96,326	7,563	289,821	23,300	538,344	30,160	13,135	4,457
Rockfish									1,304,810	39,626
Salmon	60,226	13,291	1,793	353					130,004,835	3,504,622
Scup	7,818,530	189,429	1,466,931	43,350						
Sea-bass	475,700	26,477	2,467,676	126,668	873,095	36,420	17,095	457	943,156	20,642
Shad	1,380,812	58,564	31,897,687	1,253,622	9,849,338	605,539	150	3	1,254,801	15,898
Sheepshead			17,165	1,317	635,830	18,285	1,974,815	48,590		
Smelt	1,079,448	100,364							2,280,249	68,214
Snappers, red	68,750	2,750			155,100	8,203	13,608,553	410,157		
Snappers, other					42,543	977	358,806	10,442		

PRODUCTS OF THE FISHERIES OF THE UNITED STATES.—*Continued.*

Species.	New England States, 1902.		Middle Atlantic States, 1901.		South Atlantic States, 1902.		Gulf States, 1902.		Pacific Coast States, 1899.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Spanish mackerel	410	$64	566,096	$51,027	1,013,172	$54,322	1,583,891	$64,458		
Spot			1,133,189	28,370	926,946	21,425	155,600	3,356		
Squeteague	7,336,052	177,622	23,496,383	558,653	4,848,269	190,380	4,789,047	173,207		
Striped bass	135,633	13,662	1,838,919	178,848	1,187,700	114,574			1,234,320	$61,814
Sturgeon	17,980	1,349	648,610	33,886	218,075	11,209	467,391	13,662	295,344	15,333
Sturgeon, shovel-nose										
Suckers	126,307	4,651	424,059	19,104	169,350	4,899	4,800	372		
Sunfish	9,020	380	25,015	1,585	660,514	14,685	44,050	2,134		
Swordfish	1,689,740	118,320								
Tautog	605,570	20,253	144,367	5,114	2,650	53				
Whitefish									58,010	1,169
Other fish	3,449,138	29,210	2,825,386	60,620	2,434,909	98,451	3,545,566	95,837	4,749,054	79,635
Caviar	455	281	57,842	33,630	20,780	13,284	11,105	5,336		
Crabs	15,786	2,160	23,650,655	495,385	385,707	18,950	1,708,625	29,741	4,061,980	99,518
Lobsters	14,028,845	1,271,962	252,242	30,376						
Spiny lobsters									606,713	14,198
Crawfish							71,664	3,897	116,400	7,760
Shrimp and prawn	7,200	1,740	7,673	2,838	3,810,641	86,640	12,366,915	198,979	1,621,600	107,957
Squid	5,496,461	28,409	198,594	5,940					622,740	18,682
Clams	8,993,430	586,535	9,300,474	1,075,264	1,415,440	100,752	800	100	6,281,549	63,727
Oysters	19,550,643	2,193,316	138,247,739	10,287,556	22,719,074	644,478	34,115,935	1,263,689	34,760,420	1,043,192
Scallops	632,728	130,674	1,223,724	110,537	13,020	980			3,939	738
Abalone and mussels			637,000	2,780					752,687	26,690
Terrapin and turtle			158,219	12,564	120,524	30,587	563,956	50,060	107,869	10,376
Frogs			16,307	1,573	5,990	599			20,687	20,638
Sponges							346,889	364,422		
Oil, fish	185,703	8,039								
Oil, whale	5,136,767	292,875							522,300	20,491
Whalebone	19,000	90,000							207,392	436,272
Fur-seal pelts									375	1,000
Alligator hides					100,687	13,538	249,240	27,241		
Otter skins					2,927	17,352	356	1,015		
Oyster shells			2,430,000	1,362						
Mussel shells										
Other products	2,994,560	79,563	1,130,200	4,091	1,554,320	2,621	4,429	2,721	3,155,739	24,892
Total	528,943,797	12,280,401	819,046,576	17,485,500	106,446,072	2,839,633	113,696,970	3,494,196	217,965,156	6,278,639

PRODUCTS OF THE FISHERIES OF THE UNITED STATES.—*Continued.*

Species.	Mississippi River and Tributaries, 1899.		Great Lakes, 1899.		Minor Interior Waters, chiefly for 1900 and 1902.		Alaska, 1903.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Alewives									54,517,473	$469,893
Barracuda									1,226,940	33,956
Black bass	948,184	$56,652	196,216	$14,053	175,029	$18,025			2,585,772	184,899
Bluefish									18,463,973	851,404
Bonito					34,308	1,549			2,134,676	58,658
Buffalo-fish	14,215,975	349,913							17,222,585	376,469
Butter-fish									5,759,859	168,876
Catfish	7,648,179	339,800	2,182,800	68,527	677,207	32,883			17,413,416	642,863
Cod									97,951,092	2,497,681
Crappie and strawberry bass	1,318,832	61,400	60,000	1,800	25,030	810			1,657,368	71,104
Croakers									7,077,676	124,671
Cusk									5,405,824	79,418
Drum, fresh-water	3,149,232	108,786	1,380,190	9,513	12,567	899			4,547,539	119,329
Drum, salt-water									3,953,302	108,914
Eels	93,905	4,803	126,034	6,313	29,209	2,046			5,065,044	261,215
Flatfish and flounders									13,247,995	359,200
German carp	11,868,840	289,258	3,674,346	52,362	1,016,129	12,029			18,102,605	419,100
Haddock									47,088,981	959,317
Hake									33,007,988	339,180
Halibut									19,238,345	855,118
Herring							116,000	$4,060	192,293,104	932,395
Herring, lake			59,913,576	941,067	20,360	618			59,933,936	941,685
Mackerel									21,032,291	1,164,380
Menhaden									531,280,352	1,075,099
Mullet									41,756,702	712,959
Paddle-fish	2,473,250	55,514							2,473,250	55,514
Perch, white									3,780,034	221,765
Perch, yellow	65,006	2,666	9,584,802	156,350	217,715	15,332			10,469,311	197,220
Pike perch	249,435	13,955	11,070,239	380,556	371,453	26,371			11,705,802	423,203
Pike and pickerel	216,952	8,045	457,024	20,698	286,682	28,066			1,195,621	71,108
Pollock									17,744,708	170,439
Pompano									937,626	65,480
Rockfish									1,304,810	39,626
Salmon					125,858	5,629	162,491,230	10,021,617	292,683,942	13,545,512
Scup									9,285,461	232,779
Sea-bass									4,776,722	210,664
Shad	6,955	355							44,389,743	1,933,981
Sheepshead									2,627,810	68,192
Smelt					23,600	2,720			3,383,297	171,298
Snappers, red									13,832,403	421,110
Snappers, other									401,349	11,419

PRODUCTS OF THE FISHERIES OF THE UNITED STATES.—*Continued.*

Species.	Mississippi River and Tributaries 1899.		Great Lakes, 1899.		Minor Interior Waters, chiefly for 1900 and 1902.		Alaska, 1903.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Spanish mackerel									3,163,569	$169,871
Spot									2,215,735	53,151
Squeteague									40,469,751	1,099,862
Striped bass									4,396,572	368,898
Sturgeon	234,145	$8,064	1,129,348	$81,085	198,182	$7,539			3,209,075	172,127
Sturgeon, shovel-nose	711,693	19,142							711,693	19,142
Suckers	2,243,934	76,993	4,043,987	56,068	1,283,897	24,692			8,296,334	186,779
Sunfish	910,963	21,318	385,201	7,204	19,498	1,109			2,054,261	48,415
Swordfish									1,689,740	118,320
Tautog									752,587	25,420
Trout, lake			10,611,588	431,276	75,590	9,697			10,687,178	440,973
Whitefish			6,682,952	338,918	278,340	14,712			7,019,302	354,799
Other fish	1,293,618	29,497	2,015,133	38,829	899,271	222,038			21,212,075	654,117
Caviar	70,700	26,879			19,941	12,115			180,823	91,525
Crabs									29,822,753	645,754
Lobsters									14,281,087	1,302,338
Spiny lobsters									606,713	14,198
Crawfish			135,861	3,498					323,925	15,155
Shrimp and prawn	200,058	16,095							18,014,087	414,249
Squid									6,317,795	53,031
Clams									[1] 25,991,693	1,826,378
Oysters									[2] 249,393,811	15,432,231
Scallops									[3] 1,873,411	242,929
Abalone and mussels									1,389,687	29,470
Terrapin and turtle	782,015	17,148	67,211	2,324	1,113	115			1,800,907	123,174
Frogs	440,996	53,054	10,732	998	23,300	1,796			518,012	78,658
Sponges									346,889	364,422
Oil, fish							1,096,875	$34,410	[4] 1,282,578	42,449
Oil, whale									[5] 5,659,067	313,366
Whalebone									226,392	526,272
Fur-seal pelts							116,022	570,442	[6] 116,397	571,442
Alligator hides	4,950	1,238							[7] 354,877	42,017
Otter skins	1,620	4,050							[8] 4,903	22,417
Oyster shells									2,430,000	1,362
Mussel shells	47,648,000	216,404							47,648,000	216,404
Other products							2,688,000	33,600	11,527,248	147,488
Total	96,797,437	$1,781,029	113,727,240	$2,611,439	5,814,279	$440,790	166,508,127	$10,664,129	2,168,945,654	$57,875,756

NOTE.—In the above table the products of the fisheries are given in weight and value as they leave the hands of the fishermen, except that the value of salmon for Alaska is for the product after being canned or otherwise prepared for market, and the weight of clams, oysters, and other shell-fish is for the soft or edible part.

[1] 2,323,166 bushels.
[2] 31,181,253 bushels.
[3] 300,573 bushels.
[4] 171,010 gallons.
[5] 754,530 gallons.
[6] 19,462 in number.
[7] 71,360 in number.
[8] 3,308 in number.

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL.

States and Territories.	Apples.			Beans.										Coal.							Corn.				
	Apples.*	Dried Apples.	Barley.	Beans.*	Castor Beans (shelled).	Beets.	Blue-grass Seed.	Bran.*	Broom-corn Seed.	Buckwheat.	Carrots.	Charcoal.	Clover Seed.	Coal.*	Anthracite Coal.	Bituminous Coal.	Cannel Coal.	Mineral Coal.	Stone Coal.	Coke.	Corn.*	Corn in Ear, Husked.	Corn in Ear, Unhusked.	Shelled Corn.	Corn Meal.*
United States.			48		50					42						80					56				48
Alabama.		24	47	60											80							70	75	56	
Arizona.			45	[1]55																	54	70	74		
Arkansas.	[2]50	24	48	[1]60			14	20	48	52			60											56	48
California.																									
Colorado.			48	60			14			52			60	80				80				70			50
Connecticut.	48	25	48	60		[3]60		20		48	50	20	60		80										
Delaware.												20													
Dist. of Columbia																									
Florida.	[2]48	24	48	[4]60	48			20															70	56	48
Georgia.		24	47	[5]60			14	[6]20		52			60						80			70		56	48
Hawaii.			48																						
Idaho.	[2]45	28	48							42			60												
Illinois.		24	48	[5]60	46		14	20		52			60						80			70		56	48
Indian Territory.																					[7]70				
Indiana.		25	48	60	46		14			50			60					80						56	50
Iowa.	48	24	48	60	46		14	20	30	52		20	60						80	38		[8]70		56	
Kansas.	[2]48	24	48	60	46		[9]14	20		50			60						80			[10]70			50
Kentucky.		24	47	[5]60	*45		14	20		56			60	76	76	76	76	76	76		[11]70			56	50
Louisiana.																									
Maine.	44		48	62		60				48	50										56				[12]50
Maryland.												20													
Massachusetts.	48	25	48	[13]60				20		48	50		60											[14]50	50
Michigan.	48	22	48	60			14			48			60					80				[8]70		56	50
Minnesota.	[2]50	28	48	60		50	14		57	50	45	20	60	80								70		56	

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

Mississippi		26	48	[5]60	46		14	20		48			60						80			72		56	48
Missouri	48	24	48	[15]60	46		14	20		52	50		60					80					70	56	50
Montana	48			60		50	14	20		52	50		60					76				70		56	50
Nebraska		24	48	[5]60	46		14	20		52			60						80			70		56	50
Nevada																									
New Hampshire				62																	56				50
New Jersey	50	25	48	60						50			64												
New Mexico																									
New York	48	25	48	60				20		48	50		60												50
North Carolina			48							50			60												
North Dakota	50		48	60		60		20	30	42			60						80			70		56	
Ohio	50	24	48	60		56				50	50		60			80	70			40		68		56	
Oklahoma			48	60		60		20	30	42			60						80			70		56	
Oregon	45	28	46							42			60												
Pennsylvania			47							48		[16]18[17]	60	[18]75		76				40					
Rhode Island	48	25	48	60	46	50		20		48	50	20	60	80						40		70		56	50
South Carolina																									[19]48
South Dakota			48	60		60		20	30	42			60						80			70		56	
Tennessee	[2]50	24	48	[20]30[23]	46	50	14	20	42	50	50	22	[21]60						80	40		70	[22]74	56	
Texas	45	28	48					20		42		22	60						80			70	72	56	
Utah																									
Vermont	46		48	62		60				48	50		60												
Virginia		28	48	[5]60			14			52			60						80			70		56	50
Washington	[2]45	28	48							42			60												
West Virginia		25	48	60						52			60			80					56				
Wisconsin	50	25	48	60		50		20		50	50		60												50
Wyoming																									

* Not defined.

1 Small white beans, 60 pounds.
2 Green apples.
3 Sugar beets and mangel wurzel.
4 Shelled beans, 60 pounds; velvet beans, 78 pounds.
5 White beans.
6 Wheat bran.
7 Corn in ear, 70 pounds until Dec. 1 next after grown; 68 pounds thereafter.
8 In the cob.
9 English blue-grass seed, 22 pounds; native blue-grass seed, 14 pounds.
10 Indian corn in ear.
11 Corn in ear, from Nov. 1 to May 1 following, 70 pounds; 68 pounds from May 1 to Nov. 1.
12 Indian corn meal.
13 Soy beans.
14 Cracked corn.
15 Green unshelled beans, 30 pounds; green shelled beans, 56 pounds.
16 Commercially dry, for all hard woods.
17 Fifteen pounds commercially dry, for all soft woods.
18 Standard weight in Bureau of Greensburg.
19 Standard weight bushel corn meal bolted or unbolted, 48 pounds.
20 Dried beans.
21 Red and white.
22 Green unshelled corn, 100 pounds.
23 Green beans in pod.

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

States and Territories.	Corn Meal, Bolted.	Corn Meal, Unbolted.	Cotton Seed. Cotton Seed.*	Cotton Seed. Sea Island Cottonseed.	Cotton Seed. Upland Cotton Seed.	Cranberries.	Flaxseed (linseed).	Gooseberries.	Plastering Hair.	Hemp Seed.	Herds Grass.	Hungarian Grass Seed.	Indian Corn or Maize.	Lime. Lime.*	Lime. Unslaked Lime.	Malt.	Millet.	Oats.	Onions. Onions.*	Onions. Onion Sets.	Orchard Grass Seed.	Osage Orange Seed.	Parsnips.	Peaches. Peaches.*	Peaches. D'd Peaches, Peeled.
United States.							56									34		32							
Alabama.			32															32							38
Arizona.																		32							
Arkansas.			33⅓				56										50	32	57						33
California.																									
Colorado.										44			56	80				32	57						
Connecticut.				44	30		55				45		56	70				32	52				45		33
Delaware.	44	48											56												
Dist. of Columbia																									
Florida.			32	46													50	32	56					[1]54	33
Georgia.			30				56		8	44					80			32	57						38
Hawaii.													56					32							
Idaho.							56						56					36							
Illinois.							56		8	44					80	38		32	57						
Indian Territory.																									
Indiana.						33				44						[2]35	50	32	48		14	33	55		
Iowa.							56	40		44		50		80			50	32	57			32		48	
Kansas.							56		[3]8	44		50	[4]56		80		50	32	57						
Kentucky.							56		8	44		50			35		50	[4]32	57	[5]36	14				39
Louisiana.																									
Maine.									11									[6]30	52						
Maryland.																		26							
Massachusetts.				44	30		55				45		[4]56	70				32	52						33
Michigan.						40	56			44		50		70			50	32	54		14	33			28

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

Minnesota						36		40	[3] 8	50		48		80			48	32	52		14		42		28
Mississippi	44	48	32				56			44		50			80	38	50	32	57						33
Missouri			33				56			44		48				38	50	32	57	[7]28	14	36	44	48	33
Montana							56			44		50			80	30		32	57				50		
Nebraska							56		8	44		50			80	30	50	32	57	25		32			33
Nevada																									
New Hampshire																		32							
New Jersey							55						56					30	57						33
New Mexico																									
New York				44	30		55				45		56	70				32	57						33
North Carolina	46	48	30				55						56					32							
North Dakota																	50	32	52						
Ohio							56			44		50		70		34	50	32	55					48	33
Oklahoma							56							80				32	52						
Oregon													56					32							28
Pennsylvania													56					32	50						
Rhode Island				44	30		56			44		50		70		38	50	32	50				50	48	33
South Carolina	46	48	30																						
South Dakota							56							80				32	52						
Tennessee	50	48	28				56	48	8	44		48		([8])	80		[9]50	32	[10]56	[7]28[11]	14	33	50	[10]50	26*
Texas			32				56			44		48					50	32	57					50	28
Utah																									
Vermont											45		56					32	52						
Virginia			32				56		8	44	12	48			80	38	50	30	57	28	14	34			40
Washington							56						56					32							28
West Virginia							56											32							33
Wisconsin				44	30		56			44		48	56	70	80	34	50	32	57				44		33
Wyoming																									

* Not defined.

[1] Green peaches.
[2] Rye malt.
[3] Unwashed plastering hair, 8 pounds; washed plastering hair, 4 pounds.
[4] Shelled.
[5] Bottom onion sets.
[6] Strike measure.
[7] Top onion sets, 28 pounds.
[8] Slaked lime, 40 pounds.
[9] German Missouri and Tennessee millet seed.
[10] Matured.
[11] Button onion sets, 32 pounds.

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

States and Territories.	D'd Peaches, Unpeeled.	Peanuts.	Peas.			Pears.*	Potatoes.			Red Top.	Rough Rice.	Rice Corn.	Rutabagas.	Rye Meal.	Rye	Salt.			Shorts.*	Sorghum Seed.	Tomatoes.	Timothy Seed.	Turnips.		Wheat.
			Ground Peas.	Green Peas, Unshelled.	Peas.*		Potatoes.*	Sweet Potatoes.	White Potatoes.							Salt.*	Fine Salt.	Coarse Salt.					Turnips.*	C'mon English Turnips.	
United States					60		60								56										60
Alabama	33				60			55	60						56								55		60
Arizona							60	50	60						56										60
Arkansas	33				60					14					56	50				50		60	57		60
California																									
Colorado							60								56	80						45			60
Connecticut	33				60		60	54	60		45		60	50	56		50	70	20					50	60
Delaware																									60
Dist. of Columbia							60																		
Florida		22				60		60	60						56	60				56			54		60
Georgia	33		25		60			55	60		43				56							45	55		60
Hawaii															56										60
Idaho	28					[1]45	60								56										60
Illinois	33							50	60						56		55	50				45	55		60
Indian Territory																									
Indiana	33						60	55							56	50						45	55		60
Iowa	33						60	46							56	50				[2]30		45			60
Kansas	33						60	50				56			56	50				56		45	55		60
Kentucky			24		60		60	55	60						56	50	55					45	60		60
Louisiana																									
Maine					60		60						60	50			60	70						50	60
Maryland							56														60				
Massachusetts					60		60	54			45			50	56		50	70	20			45			60

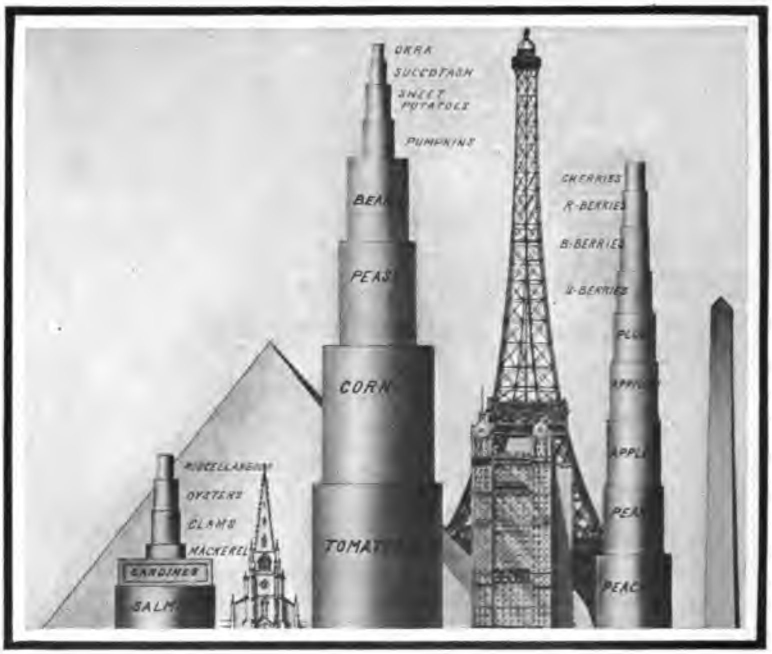
LEGAL WEIGHTS (IN POUNDS) PER BUSHEL—*Continued.*

Michigan					60			56	60	[3]14					56	56						45	58		60
Minnesota					60			55	60	[3]14			52		56					57		45			60
Mississippi			24		60			60	60						56	50				42		45	55		60
Missouri				56	[4]60	48		56	60	[3]14			50		56	50				42	45	45		42	60
Montana					60	48	60								56	50						45	50		60
Nebraska					60			50	60						56	50				30		45	55		60
Nevada																									
New Hampshire					60		60							50	56										60
New Jersey					60			54	60						56										60
New Mexico																									
New York					60			54	60		45			50	56		56	70	20			45			60
North Carolina		22			60						44				56										60
North Dakota					60			46	60						56	80						45	60		60
Ohio					60			50	60						56						56	45	60		60
Oklahoma					60			46	60						56	80						42	60		60
Oregon						45	60								56										60
Pennsylvania							56								56										60
Rhode Island					[4]60			54	60					50	56		50	70	20		56	45	50		60
South Carolina																									
South Dakota					60			46	60						56	80						42	60		60
Tennessee		23		30	[8]60	[5]56		50	60	14					56	50				50	56	45	50		60
Texas								55	60						56	50					55	45	55		60
Utah																									
Vermont					60		60								56	70						45	60		[7]60
Virginia	32	22			[6]60			56	60	12					56	50						45	55		60
Washington						[1]45	60								56										60
West Virginia							60								56							45			60
Wisconsin					60			54	60		45		56	50	56		50	70	20			45	42		60
Wyoming																									

* Not defined.

[1] Green.
[2] Sorghum saccharatum seed.
[3] Seed.
[4] Including split peas.
[5] Matured pears, 56 pounds; dried pears, 26 pounds.
[6] Black-eyed peas.
[7] India wheat, 46 pounds.
[8] Dry.

—U. S. Bureau of Standards.



COMPARISON OF CANNED GOODS PUT UP IN THE UNITED STATES IN 1900.

Cans, Tin.—Size of sheet for from 1 to 100 gallons.

For 1	gal.	10×20 in.	For 25	gal.	30×56 in.
" 3½	"	10×28 "	" 40	"	36×63 "
" 5	"	12×40 "	" 50	"	40×70 "
" 6	"	14×40 "	" 75	"	40×84 "
" 10	"	20×42 "	" 100	"	40×98 "
" 15	"	30×42 "			

This includes all the laps, seams, etc. Is sufficiently correct for all practical purposes.

Wire, *to Ascertain Amount Required for Cable.*—For the length of a wire in a strand, add to a given length as many times the circumference of the strand as there are twists in the given length, for the outside wires; and proportionately for the inner row. The centre wire is supposed to be straight. Proceed in the same way for the strands. The excess of wire in each strand added to the excess of the strands over the length of the cable will give the whole length of wire used.

CHAPTER XVI.

MISCELLANEOUS INFORMATION.

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES: 1902.

ITEMS.	Total.	Private stations.	Municipal stations.
Number of stations	3,620	2,805	815
Condensed statement—income and expenses:			
Earnings from operation, total	$84,186,605	$77,349,749	$6,836,856
Arc lighting	$25,481,045	$22,091,800	$3,389,245
Incandescent lighting	$44,657,102	$41,297,484	$3,359,618
All other electric service	$14,048,458	$13,960,465	$87,993
Income from all other sources	$1,514,000	$1,385,751	$128,249
Gross income	$85,700,605	$78,735,500	$6,965,105
Expenses, total	$68,081,375	$62,835,388	$5,245,987
Salaries and wages	$20,646,692	$18,766,970	$1,879,722
Supplies, materials, and fuel	$22,915,932	$20,493,641	$2,422,291
Rents, taxes, insurance, and miscellaneous	$11,895,206	$11,456,037	$439,169
Interest on bonds	$12,623,545	$12,118,740	$504,805
Analysis of income:			
Aggregate	$85,700,605	$78,735,500	$6,965,105
Arc lighting, total	$25,481,045	$22,091,800	$3,389,245
Commercial or other private	$8,460,320	$8,220,154	$240,166
Public	$17,020,725	$13,871,646	$3,149,079
Incandescent lighting, total	$44,657,102	$41,297,484	$3,359,618
Commercial or other private	$41,907,853	$39,039,557	$2,868,296
Public	$2,749,249	$2,257,927	$491,322
Motor service	$9,910,217	$9,839,677	$70,540
Electric railway service	$2,304,515	$2,301,343	$3,172
Electric heating	$39,213	$39,155	$58
Charging automobiles	$30,056	$29,959	$97
All other electric service	$1,764,457	$1,750,331	$14,126
All other sources	$,1,514,000	$1,385,751	$128,249
Analysis of supplies, materials, and fuel:			
Aggregate cost	$22,915,932	$20,493,641	$2,422,291
Meters—			
Number	27,632	25,739	1,893
Cost	$416,994	$390,569	$26,425
Motors—			
Number	602	572	30
Cost	$30,099	$29,202	$897
Transformers—			
Number	13,288	7,843	5,445
Cost	$365,028	$326,407	$38,621
Incandescent lamps—			
Number	8,839,905	8,399,571	440,334
Cost	$1,507,249	$1,426,224	$81,025
Incandescent lamp fittings, sockets, etc., cost	$177,236	$154,517	$22,719
Carbons for arc lamps—			
Number	94,686,596	82,156,930	12,529,666
Cost	$1,051,386	$900,788	$150,598
Globes for arc lamps—			
Number	485,073	428,979	56,094
Cost	$170,929	$150,509	$20,420
Arc lamp repairs, cost	$244,537	$212,231	$32,306
Poles or other supports, cost	$346,587	$319,617	$26,970
Wire and cable cost	$1,152,915	$1,081,380	$71,535
Mill supplies (oil, waste, etc.), cost	$712,797	$617,911	$94,886
All other materials, cost	$1,853,544	$1,747,896	$105,648
Power purchased, cost	$2,130,759	$2,007,193	$123,566
Freight paid, not included in other items	$1,120,363	$939,512	$180,851

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

ITEMS.	Total.	Private stations.	Municipal stations.
Analysis of supplies, materials, and fuel—*Contin'd.*			
Fuel, cost	$11,635,509	$10,189,685	$1,445,824
Coal—			
Tons	4,817,597	4,249,137	568,460
Cost	$9,943,125	$8,749,394	$1,193,731
Crude petroleum, cost	$721,838	$700,136	$21,702
Natural gas, cost	$254,269	$220,460	$33,809
Manufactured gas, cost	$28,654	$20,135	$8,519
All other fuel, cost	$687,623	$499,560	$188,063
Average number of employees, total salaries, wages:			
Salaried officials and clerks—			
Average number, total	6,996	6,046	950
Salaries, total	$5,663,580	$5,206,199	$457,381
General officers—			
Average number	1,587	1,416	171
Salaries	$1,501,522	$1,465,471	$36,051
Other officers, managers, superintendents, etc.—			
Average number	2,393	1,875	518
Salaries	$2,445,227	$2,088,298	$356,929
Clerks—			
Average number	3,016	2,755	261
Salaries	$1,716,831	$1,652,430	$64,401
Wage-earners—			
Average number, total	23,330	20,863	2,467
Wages, total	$14,983,112	$13,560,771	$1,422,341
Foremen—			
Average number	1,000	943	57
Wages	$953,738	$910,972	$42,766
Inspectors—			
Average number	571	546	25
Wages	$415,904	$397,983	$17,921
Engineers—			
Average number	4,587	3,743	844
Wages	$3,259,870	$2,721,127	$538,743
Firemen—			
Average number	3,456	2,951	505
Wages	$1,963,465	$1,717,149	$246,316
Dynamo and switchboard men—			
Average number	1,978	1,872	106
Wages	$1,351,676	$1,286,065	$65,611
Linemen—			
Average number	4,217	3,868	349
Wages	$2,710,841	$2,510,269	$200,572
Mechanics—			
Average number	1,057	1,009	48
Wages	$796,355	$768,694	$27,661
Lamp trimmers—			
Average number	2,637	2,318	319
Wages	$1,654,462	$1,460,046	$194,416
All other employees—			
Average number	3,827	3,613	214
Wages	$1,876,801	$1,788,466	$88,335
Analysis of miscellaneous expenses:			
Total	$11,895,206	$11,456,037	$439,169
Rent of stations, supports, conduits, etc	$1,011,691	$1,001,504	$10,187
Rent of offices	$275,007	$270,446	$4,561
Taxes	$2,665,005	$2,654,885	$10,120
Injuries and damages	$248,304	$246,545	$1,759
Insurance	$893,567	$827,926	$65,641
Ordinary repairs of buildings and mach'y	$2,701,747	$2,480,217	$221,530
All other	$4,099,885	$3,974,514	$125,371
Electric line construction:			
Aggregate miles—			
Mains	107,263.63	93,352.95	13,910.68
Feeders	17,880.51	16,452.28	1,428.23
Lighting and stationary motor service, miles—			
Mains, total	107,184.13	93,273.45	13,910.68
Feeders, total	17,760.26	16,332.03	1,428.23

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

ITEMS.	Total.	Private stations.	Municipal stations.
Electric line construction—*Continued:*			
Underground—			
Mains	5,847.71	5,408.55	439.16
Feeders	2,276.55	2,262.02	14.53
Overhead—			
Mains	101,304.26	87,833.63	13,470.63
Feeders	15,472.34	14,061.50	1,410.84
Submarine—			
Mains	32.16	31.27	0.89
Feeders	11.37	8.51	2.86
Electric railway car service owned by lighting companies, miles—			
Mains	79.50	79.50	....
Feeders	120.25	120.25	....
Power and generating equipment:			
Steam engines—Number, total	5,930	4,870	1,060
Horsepower, total	1,379,941	1,232,923	147,018
500 horsepower and under—			
Number	5,451	4,407	1,044
Horsepower	849,336	715,418	133,918
Over 500 and under 1,000 horsepower			
Number	278	266	12
Horsepower	193,570	184,670	8,900
1,000 horsepower and over—			
Number	201	197	4
Horsepower	337,035	332,835	4,200
Water wheels—			
Number, total	1,390	1,308	82
Horsepower, total	438,472	427,254	11,218
500 horsepower and under—			
Number	1,187	1,107	80
Horsepower	173,903	164,325	9,578
Over 500 and under 1,000 horsepower			
Number	90	89	1
Horsepower	57,816	57,176	640
1,000 horsepower and over—			
Number	113	112	1
Horsepower	206,753	205,753	1,000
Gas engines—			
Number	165	147	18
Horsepower	12,181	11,224	957
Auxiliary steam engines—			
Number	365	329	36
Horsepower	14,454	13,619	835
Dynamos—			
Number, total	12,484	10,662	1,822
Horsepower, total	1,624,980	1,472,996	151,984
Direct current, constant voltage—			
Number	3,823	3,405	418
Horsepower	442,446	418,913	23,533
Direct current, constant amperage—			
Number	3, 539	2,957	582
Horsepower	195,531	157,768	37,763
Alternating and polyphase current—			
Number	5,122	4,300	822
Horsepower	987,003	896,315	90,688
Boosters—			
Number	193	184	9
Horsepower	17,911	17,735	176
Rotaries—			
Number	132	131	1
Horsepower	63,817	63,683	134
Storage battery cells in main plants—			
Number	6,881	5,981	900
Horsepower	16,355	16.335	20
Substation plants:			
Horsepower, total	552,950	551,467	1,483
Storage battery cells—			
Number	8,388	8,388	....
Horsepower	25,284	25,284	....

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

ITEMS.	Total.	Private stations.	Municipal stations.
Substation plants—*Continued:*			
Transformers—			
Number	2,525	2,490	35
Horsepower	420,667	419,368	1,299
Rotary converters—			
Number	163	162	1
Horsepower	85,556	85,546	10
Miscellaneous—			
Number	140	135	5
Horsepower	21,443	21,269	174
Transformers on circuits for consumers:			
Number	207,151	179,081	28,070
Horsepower	922,774	822,668	100,106
Meters on consumers' circuits, total	582,689	526,011	56,678
Mechanical	575,004	518,428	56,576
Chemical	7,685	7,583	102
Output of stations:			
Kilowatt hours—			
Total for year	2,507,051,115	2,311,146,676	195,904,439
Average per day	6,960,783	6,413,012	547,771
Horsepower hours of current—			
Total for year	3,341,943,090	3,083,212,074	258,731,016
Average per day	9,294,456	8,566,231	728,225
Analysis of service:			
Arc lighting—number of lamps in service—			
Aggregate	385,698	334,903	50,795
Commercial or other private, total	173,973	168,180	5,793
Open	42,988	41,622	1,366
Inclosed	130,985	126,558	4,427
Direct current	104,176	101,849	2,327
Open	38,120	36,856	1,264
Inclosed	66,056	64,993	1,063
Alternating current	67,538	64,085	3,453
Open	3,733	3,631	102
Inclosed	63,805	60,454	3,351
All other	2,259	2,246	13
Open	1,135	1,135	....
Inclosed	1,124	1,111	13
Public, total	211,725	166,723	45,002
Open	138,684	108,082	30,602
Inclosed	73,041	58,641	14,400
Direct current	154,749	119,520	35,229
Open	125,298	96,659	28,639
Inclosed	29,451	22,861	6,590
Alternating current	48,063	38,316	9,747
Open	4,630	2,681	1,949
Inclosed	43,433	35,635	7,798
All other	8,913	8,887	26
Open	8,756	8,742	14
Inclosed	157	145	12
Incandescent lighting—lamps in service—			
Aggregate	18,194,044	16,616,593	1,577,451
Commercial or other private, total	17,738,384	16,243,853	1,494,531
16-candlepower	15,261,067	13,890,281	1,370,786
32-candlepower	514,679	484,246	30,433
All other candlepower	1,962,638	1,869,326	93,312
Public, total	455,660	372,740	82,920
16-candlepower	296,776	235,842	60,934
32-candlepower	59,988	47,063	12,925
All other candlepower	98,896	89,835	9,061
Motors in service—			
Stationary—			
Number	101,064	99,102	1,962
Horsepower	624,686	619,283	5,403
Railway car, number of cars served	2,379	2,370	9
Character of ownership:			
When installed—			
Individual	1,041	964	77
Corporation	1,921	1,828	93
Municipal	658	13	645

CENTRAL ELECTRIC LIGHT AND POWER STATIONS, UNITED STATES, 1902—*Continued.*

ITEMS.	Total.	Private stations.	Municipal stations.
Character of ownership—*Continued:*			
In 1902—			
Individual	756	756	....
Corporation	2,049	2,049	....
Municipal	815	....	815
Character of service:			
Arc lighting—			
Commercial or other private	2,020	1,667	353
Public	2,522	1,810	712
Incandescent lighting—			
Commercial or other private	3,484	2,752	732
Public	2,491	1,889	602
Motor power—			
Stationary	1,093	975	118
Electric railway	159	157	2
All other	161	152	9
Stocks and bonds issued, total par value	$639,125,363	$627,515,875	$11,609,488
Capital stock:			
Authorized, total	$435,178,372	$435,178,372	....
Issued, total	$372,951,952	$372,951,952	....
Dividends, total	$6,189,837	$6,189,837	....
Common—			
Authorized	$407,807,934	$407,807,934	....
Issued	$349,080,281	$349,080,281	....
Dividends	$5,560,341	$5,560,341	....
Preferred—			
Authorized	$27,370,438	$27,370,438	....
Issued	$23,871,671	$23,871,671	....
Dividends	$629,496	$629,496	....
Bonds:			
Authorized	$320,743,376	$308,117,894	$12,625,482
Outstanding	$266,173,411	$254,563,923	$11,609,488
Interest	$12,623,545	$12,118,740	$504,805
Cost of construction and equipment:			
To date	$504,740,352	$482,719,879	$22,020,473
During the year	$41,792,447	$40,050,613	$1,741,834

—*Census Reports.*

COMPARATIVE VELOCITIES, PER SECOND.

Snail (0.0394 inch), 1 millimeter.
Pedestrian (39.37 inches) 1 meter = 1.09 ya.
Horse, walking, 1.2 meters = 1.31 yards.
Pedestrian, quick walk, 2 meters = 2.19 ya.
Horse, trotting, 3.5 meters = 3.82 yards.
Mild wind, 4 meters = 4.37 yards.
Horse, galloping, 4.5 meters = 4.91 yards.
Steamer, ordinary, 5 meters = 5.47 yards.
Sail-boat, 8 meters = 8.75 yards.
Ocean steamer, 10 meters = 10.93 yards.
Skater, 12 meters = 13.08 yards.
Freight train, 12 meters = 13.08 yards.
Gale, 17 meters = 18.53 yards.
Passenger train, 18 meters = 19.62 yards.
Carrier pigeon, 18 meters = 19.62 yards.
Bicycle, racing, 20 meters = 21.87 yards.
Race horse, 25 meters = 27.05 yards.
Express train, 26 meters = 28.14 yards.
Swallow, 45 meters = 49.05 yards.
Sound, 330 meters = 360.70 yards.
Rifle-ball (breech-loader), 430 meters = 468.70 yards.
Cannon ball, 450 meters = 490.50 yards.
Axial revolution of the earth at equator, 450 meters = 490.50 yards.
Revolutions of the earth around the sun, 30 kilometers = 18.64 miles.
Light, 300,000 kilometers = 186,400 miles.
Electricity, 400,000 kilometers = 248,500 mi.

TABLE OF ELEVATIONS OF OBJECTS ABOVE SEA LEVEL, WITH THEIR CORRESPONDING DISTANCES OF VISIBILITY.

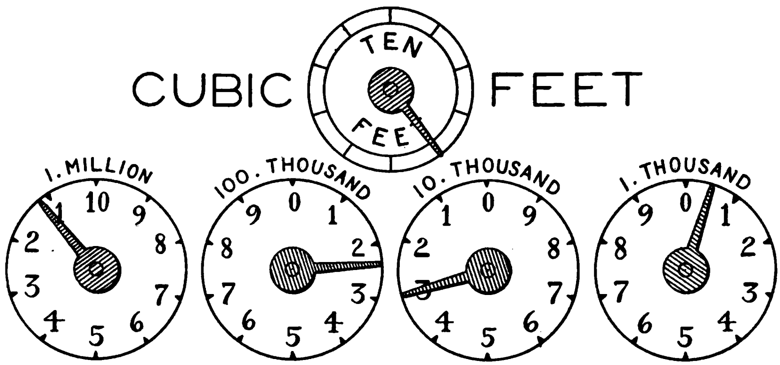
Height, in Feet.	Distance, in Nautical Miles.	Height, in Feet.	Distance, in Nautical Miles.
5	2.555	50	8.081
10	3.614	100	11.428
15	4.426	250	18.070
20	5.111	500	25.555
25	5.714	1,000	36.140

Distances corresponding to heights not included in the above table may be found by the formula $D=\frac{8}{7}\sqrt{H}$, in which H = the elevation, or height, in feet, of the object above sea-level, and D = the corresponding distance of visibility, in nautical miles. The formula is based on the mean curvature of the earth and is corrected for ordinary atmospheric refraction.

The distance of visibility of a light may be augmented by abnormal atmospheric refraction, which usually increases with the height of the barometer and a falling temperature.

HOW TO READ A GAS METER.

The dial marked "1 THOUSAND" in the accompanying illustration is divided into hundreds; the dial marked "10 THOUSAND" is divided into thousands; that marked "100 THOUSAND" into ten-thousands, and that marked "1 MILLION" into hundred-thousands. When 1,000 cubic feet of gas have been consumed, the pointer on the dial marked "1 THOUSAND" will have made a complete rotation and the fact will be indicated by the pointer of the next dial at the left, which will point to the figure 1. When 10,000 cubic feet of gas have been consumed, the pointer on the "10 THOUSAND" dial will point to 1, and so on. In reading a gas meter, put down the hundreds first, then the thousands, and so on, always counting the figure just under, or which has just been passed by, the pointer. In the illustration about half a hundred is indicated on the "1 THOUSAND" dial, three thousands is indicated on the next dial, two ten-thousands on the next dial, and one one-hundred-thousands on the "1 MILLION" dial. The reading will be 123,050. The dial marked "TEN FEET" is called the units dial. It is used for testing the meter to discover whether it is in working order or not. Each mark represents a cubic foot and the complete circle 10 cubic feet. If the pointer moves when no gas is burning, it indicates a leak. If it does not move when the gas is burning, or if its motion is unsteady, it indicates a derangement in the mechanism and shows that the meter requires attention.



GAS METER INDICATOR DIALS.

PAPER CURRENCY OF EACH DENOMINATION OUTSTANDING MAY 31, 1904.

[Prepared by Treasurer's Office.]

Denomination.	United States Notes.	Treasury Notes of 1890.	National-bank Notes.	Gold Certificates.	Silver Certificates.	Total.
	Dollars	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
One dollar	1,923,494	636,992	345,145	....	79,851,727	82,757,358
Two dollars	1,472,334	486,068	165,282	....	45,045,050	47,168,734
Five dollars	12,278,660	3,189,330	62,602,840	....	281,708,442	359,779,272
Ten dollars	243,517,011	5,679,520	188,067,250	....	39,648,331	476,912,112
Twenty dollars	36,775,242	2,488,590	140,632,200	172,387,164	18,658,620	370,941,816
Fifty dollars	5,906,875	47,500	17,427,600	34,727,905	5,095,810	63,205,690
One hundred dollars	11,200,900	510,000	36,591,500	51,145,300	1,493,020	100,940,720
Five hundred dollars	9,748,500	....	95,500	14,236,000	50,000	24,130,000
One thousand dollars	24,838,000	435,000	24,000	56,908,500	111,000	82,316,500
Fivethousand dollars	10,000	....	....	49,590,000	....	49,600,000
Ten thousand dollars	10,000	....	....	110,980,000	....	110,990,000
Fractional parts	....	....	37,248	....	....	37,248
Total	347,681,016	13,473,000	445,988,565	489,974,869	471,662,000	1,768,779,450
Unknown, destroyed	1,000,000	....	....	....	....	1,000,000
Net	346,681,016	13,473,000	445,988,565	489,974,869	471,662,000	1,767,779,450

AMOUNTS OF GOLD AND SILVER COIN AND CERTIFICATES, UNITED STATES NOTES, AND NATIONAL BANK NOTES IN CIRCULATION AND IN THE TREASURY MAY 1 AND JUNE 1, 1904, RESPECTIVELY.

[NOTE.—Population of the United States, June 1, 1904, estimated at 81,752,000; circulation per capita, $30.69.]

Classification.	General Stock of Money in the United States, June 1, 1904.	Held in Treasury as Assets of Gov't.,[1] June 1, 1904.	Money in Circulation, June 1, 1904.
	Dollars.	Dollars.	Dollars.
Gold coin (including bullion in Treasury)....	1,313,120,868	217,592,391	644,894,548
Gold certificates [2]	....	....	450,633,929
Standard silver dollars..................	559,422,410	22,659,857	72,605,727
Silver certificates [2]	....	....	464,156,826
Subsidiary silver........................	106,614,930	12,035,831	94,579,099
Treasury notes of 1890..................	13,473,000	98,576	13,374,424
United States notes......................	346,681,016	9,376,636	337,304,380
Currency certificates, act of June 8, 1872 [2] ...	....	....	....
National-bank notes......................	445,988,565	14,257,581	431,730,984
Total..........................	2,785,300,789	276,020,872	2,509,279,917

[1] This statement of money held in the Treasury as assets of the Government does not include deposits of public money in national-bank depositaries to the credit of the Treasurer of the United States, and amounting to $106,849,757.45.

[2] For redemption of outstanding certificates an exact equivalent in amount of the appropriate kinds of money is held in the Treasury, and is not included in the account of money held as assets of the Government.

PUBLIC DEBT OF THE UNITED STATES.

Classification.	May 31, 1904.
	Dollars.
Interest-bearing debt..	895,157,430.00
Debt on which interest has ceased since maturity..........................	2,109,950.26
Debt bearing no interest..	391,321,769.38
Aggregate of interest and non-interest bearing debt..................	1.288,589,149.64
Certificates and Treasury notes offset by an equal amount of cash in the Treasury..	975,109,869.00
Aggregate of debt, including certificates and Treasury notes...........	2,263,699,018.64

GOLD BARS, VALUE $100 TO $8,000 EACH.

VALUES OF FOREIGN COINS.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY, *Washington, July* 1, 1904.

In pursuance of the provisions of section 25 of the act of August 28, 1894, I hereby proclaim the following estimate by the Director of the Mint of the values of foreign coins to be the values of such coins in terms of the money of account of the United States, to be followed in estimating the value of all foreign merchandise exported to the United States on and after July 1, 1904, expressed in any of such metallic currencies.

LESLIE M. SHAW, *Secretary.*

COUNTRY.	Standard.	Monetary unit.	Value in terms of U. S. gold dollar.	Coins.
Argentine Republic	Gold	Peso	$0.965	Gold: argentine (4.824) and ½ argentine. Silver: peso and divisions.
Austria-Hungary	Gold	Crown	.203	Gold: former system—4 florins ($1.929), 8 florins ($3.858), ducat ($2.287) and 4 ducats ($9.149). Silver 1 and 2 florins. Gold: present system—20 crowns ($4.052); 10 crowns ($2.026).
Belgium	Gold	Franc	.193	Gold: 10 and 20 francs. Silver: 5 francs.
Bolivia	Silver	Boliviano	.403	Silver: boliviano and divisions.
Brazil	Gold	Milreis	.546	Gold: 5, 10, and 20 milreis. Silver: ½, 1, and 2 milreis.
British Possessions, N. A. (except Newf'nd).	Gold	Dollar	1.000	
Central Amer. States:				
Costa Rica	Gold	Colon	.465	Gold: 2, 5, 10, and 20 colons ($9.307). Silver: 5, 10, 25, and 50 centimos.
British Honduras	Gold	Dollar	1.000	
Guatemala, Honduras, Nicaragua, Salvador	Silver	Peso	.403	Silver: peso and divisions.
Chile	Gold	Peso	.365	Gold: escudo ($1.825), doubloon ($3.650), and condor ($7.300). Silver: peso and divisions.
China	Silver	Tael: Amoy	.661	
		Canton	.659	
		Chefoo	.632	
		Chinkiang	.645	
		Fuchau	.611	
		Haikwan (Customs)	.672	
		Hankow	.618	
		Hongkong	(*)	
		Nankin	.654	
		Niuchwang	.620	
		Ningpo	.635	
		Pekin	.644	
		Shanghai	.603	
		Swatow	.610	
		Takau	.665	
		Tientsin	.640	

VALUES OF FOREIGN COINS.—Continued.

COUNTRY.	Standard.	Monetary unit.	Value in terms of U. S. gold dollar.	Coins.
Colombia	Silver	Peso	.403	Gold: condor ($9.647) and double-condor. Silver: peso.
Cuba	Gold	Peso	.926	Gold: Doubloon Isabella, centen ($5.017). Alphonse ($4.823). Silver: peso.
Denmark	Gold	Crown	.268	Gold: 10 and 20 crowns.
Ecuador	Gold	Sucre	.487	Gold: 10 sucres ($4.8665). Silver: sucre and divisions.
Egypt	Gold	Pound (100 piasters)	4.943	Gold: pound (100 piasters), 5, 10, 20, and 50 piasters. Silver: 1, 2 5, 10, and 20 piasters.
Finland	Gold	Mark	.193	Gold: 20 marks ($3.859), 10 marks ($1.93).
France	Gold	Franc	.193	Gold: 5, 10, 20, 50, and 100 francs. Silver: 5 francs.
German Empire	Gold	Mark	.238	Gold: 5, 10, and 20 marks.
Great Britain	Gold	Pound sterling	4.866½	Gold: sovereign (pound sterling) and ½ sovereign.
Greece	Gold	Drachma	.193	Gold: 5, 10, 20, 50, and 100 drachmas. Silver: 5 drachmas.
Haiti	Gold	Gourde	.965	Gold: 1, 2, 5, and 10 gourdes. Silver: gourde and divisions.
India	Gold	Pound sterling†	4.866½	Gold: sovereign (pound sterling). Silver: rupee and divisions.
Italy	Gold	Lira	.193	Gold: 5, 10, 20, 50, and 100 lire. Silver: 5 lire.
Japan	Gold	Yen	.498	Gold: 5, 10, and 20 yen. Silver: 10, 20, and 50 sen.
Liberia	Gold	Dollar	1.000	
Mexico	Silver	Dollar	.438	Gold: dollar ($0.983), 2½, 5, 10, and 20 dollars. Silver: dollar (or peso) and divisions.
Netherlands	Gold	Florin	.402	Gold: 10 florins. Silver: ½, 1, and 2½ florins.
Newfoundland	Gold	Dollar	1.014	Gold: 2 dollars ($2.027).
Norway	Gold	Crown	.268	Gold: 10 and 20 crowns.
Persia	Silver	Kran	.074	Gold: ½, 1, and 2 tomans ($3.409). Silver: ¼, ½, 1, 2, and 5 krans.
Peru	Gold	Sol	.487	Gold: libra ($4.8665). Silver: sol and divisions.
Philippine Islands	Gold	Peso	.50	Silver peso: 50, 20, and 10 centavos.
Portugal	Gold	Milreis	1.080	Gold: 1, 2, 5, and 10 milreis.
Russia	Gold	Ruble	.515	Gold: imperial, 15 rubles ($7.718), and ½ imperial, 7½ rubles ($3.859). Silver: ¼, ½, and 1 ruble.
Spain	Gold	Peseta	.193	Gold: 25 pesetas. Silver: 5 pesetas.
Sweden	Gold	Crown	.268	Gold: 10 and 20 crowns.
Switzerland	Gold	Franc	.193	Gold: 5, 10, 20, 50, and 100 francs. Silver: 5 francs.
Turkey	Gold	Piaster	.044	Gold: 25, 50, 100, 250, and 500 piasters.
Uruguay	Gold	Peso	1.034	Gold: peso. Silver: peso and divisions.
Venezuela	Gold	Bolivar	.193	Gold: 5, 10, 20, 50, and 100 bolivars. Silver: 5 bolivars.

NOTE—The coins of silver-standard countries are valued by their pure silver contents, at the average market price of silver for the three months preceding the date of this circular.

* The "British dollar" has the same legal value as the Mexican dollar in Hongkong, the Straits Settlements, and Labuan.

† The sovereign is the standard coin of India, but the rupee ($0.3244⅓) is the money of account, current at 15 to the sovereign.

WORLD'S PRODUCTION OF GOLD AND SILVER FOR THE CALENDAR YEAR 1902.

Fine oz. of gold, $20.671834 +; fine oz. silver, $1.292929+, coining rate in U. S. silver dollars.

Country.	Gold.		Silver.		
	Ounces (fine).	Value.	Ounces (fine).	Coining Value.	Commercial Value.
North America:					
United States	3,870,000	$80,000,000	55,500,000	$71,757,600	$29,415,000
Mexico	491,156	10,153,100	60,176,604	77,804,100	31,893,600
Canada	1,003,355	20,741,200	4,303,774	5,564,500	2,281,000
Africa	1,887,773	39,023,700	....	....	....
Australasia	3,946,374	81,578,800	8,026,037	10,377,100	4,253,800
Europe:					
Russia	1,090,053	22,533,400	158,679	205,200	84,100
Austria-Hungary	105,037	2 171,300	1,881,132	2,432,200	997,000
Germany	3,023	62,500	5,722,641	7,399,000	3,033,000
Norway	97	2,000	206,413	266,900	109,400
Sweden	3,023	62,500	46,226	59,800	24,500
Italy	257	5,300	964,339	1,246,800	511,100
Spain	494	10,200	3,700,189	4,784,100	1,961,100
Portugal	63	1,300	3,773	4,900	2,000
Greece	....	....	1,090,188	1,409,500	577,800
Turkey	1,480	30,600	480,566	621,300	254,700
Finland	63	1,300	8,679	11,200	4,600
France	....	....	384,339	496,900	203,700
Great Britain	5,626	116,300	173,208	223,900	91,800
South America:					
Argentina	1,451	30,000	37,720	48,800	20,000
Bolivia	228	4,700	12,992,641	16,798,600	6,886,100
Chile	27,825	575,200	3,566,792	4,611,600	1,890,400
Colombia	122,031	2,522,600	1,776,604	2,297,000	941,600
Ecuador	9,675	200,000	7,736	10,000	4,100
Brazil	96,488	1,994,600	....	....	....
Venezuela	20,985	433,800	1,887	2,400	1,000
Guiana (British)	87,491	1,808,600	....	....	....
Guiana (Dutch)	15,577	322,000	....	....	....
Guiana (French)	117,077	2,420,200	....	....	....
Peru	112,525	2,326,100	4,264,528	5,513,700	2,260,200
Uruguay	2,796	57,800	755	1,000	400
Central America	96,842	2,001,900	971,320	1,255,800	514,800
Asia:					
Japan	62,259	1,287,000	390,567	505,000	207,000
China	422,401	8,731,800	....	....	....
Korea	169,313	3,500,000	....	....	....
India (British)	463,824	9,588,100	....	....	....
East Indies (British)	49,686	1,027,100	....	....	....
East Indies (Dutch)	27,312	564,600	118,302	152,900	62,700
Total	14,313,660	295,889,600	166,955,639	215,861,800	88,486,500

"GOLD BRICKS," SPURIOUS IMITATIONS, SOLD TO THE UNWARY.

COMPARATIVE VALUES OF ENGLISH AND UNITED STATES MONEY.

d	$	s	$	s	$	£	$
1	0.02	1	0.24	12	2.92	1	4.87
2	0.04	2	0.49	13	3.17	2	9.74
3	0.06	3	0.73	14	3.41	3	14.61
4	0.08	4	0.97	15	3.65	4	19.48
5	0.10	5	1.22	16	3.90	5	24.35
6	0.12	6	1.46	17	4.14	6	29.22
7	0.14	7	1.71	18	4.38	7	34.09
8	0.16	8	1.95	19	4.63	8	38.96
9	0.18	9	2.19	....		9	43.83
10	0.20	10	2.44	....		10	48.87
11	0.22	11	2.68				

HEIGHT OF BUILDINGS.

Building.	Total height from sidewalk, ft.
Park Row Building, New York..	386
American Surety Bldg., N. Y...	312
St. Paul Building, New York....	313
Manhattan Life Bldg., N. Y.....	348
Bowling Green Bldg., N. Y.....	224
Pulitzer (World) Bldg., N. Y....	309
Broad-Exchange Bldg., N. Y...	280
Wall St. Exchange Bldg., N. Y..	341
42 Broadway Bldg., New York..	260
Whitehall Bldg., New York.....	257

DIMENSIONS OF THE PRINCIPAL DOMES.

	Diam. ft.	Height. ft.
Pantheon, Rome...........	142	143
Cathedral, Florence.........	139	310
St. Peter's, Rome...........	139	330
Capitol, Washington, D. C...	135½	287½
St. Sophia, Constantinople...	115	201
Baths of Caracalla, (Ancient) Rome..................	112	116
St. Paul's, London..........	112	215

TUNNELS OF THE WORLD.

	Miles.	Under.
New York Subway (1904)*	23	City.
London Metropolitan........	13	City.
Simplon, Switzerland........	12	Mountain.
St. Gothard................	9	Mountain.
Paris Underground (incomplete)..................	8½	City.
Mount Cenis, Switzerland....	7½	Mountain.
B. & O. Tunnel, Baltimore ..	7	City.
Arlberg, Austria............	6	Mountain.
"Tube" London............	6	City.
Hoosac Tunnel, Mass........	4¾	Mountain.
Berlin, Underground........	4½	City.
Liverpool-Birkenhead.......	4½	City and Mersey River.
Boston, Mass., Subway......	2½	City.

* Other subways, tunnels, and spurs are in progress.

STRIKING THE IMPRESSION ON A GOLD PIECE AT THE MINT.

HEIGHT OF COLUMNS, SPIRES AND TOWERS.

	Feet.
Eiffel Tower, Paris	1,000
Washington Monument, Washington, D.C.	555
Pyramid of Cheops	520
St. Peter's, Rome	518
Cologne Cathedral	501
Strasburg	486
Cathedral, Antwerp	476
St. Stephen's, Vienna	465
Cathedral, Salisbury	450
Milan Cathedral	360
Cathedral, Cremona	397
St. Peter's, Rome	391
Cathedral, Florence	352
St. Paul's, London	366
Hôtel des Invalides, Paris	344
Bunker Hill Monum't, Charlestown, Mass.	221
Leaning Tower of Pisa	179
Alexander Column, St. Petersburg	175

THE WEIGHT OF BELLS.

	Pounds
Kremlin, Moscow	432,000
Amarapoora, Burmah	260,000
Pekin	130,000
St. Ivan's, Moscow	127,800
Novgorod	62,000
Sacred Heart, Paris	55,116
Sens	43,000
Vienna	40,200
Olmutz, Bohemia	40,000
Rouen	40,000
Erfurt	30,800
Westminster, "Big Ben"	30,300
Houses of Parliament, London	30,000
Notre Dame, Paris	28,600
Montreal	28,500
Cologne	25,000
City Hall, N. Y.	22,500

LENGTH OF A FEW CELEBRATED BRIDGES.

Name.	Length ft.	Type.	Spanning.
Firth of Tay, Scotland	10,779	Girder.	Firth of Tay.
Forth, Scotland	8,296	Cantilever.	Firth of Forth.
East River, New York	7,200	Suspension.	East River.
Brooklyn, New York	5,989	Suspension.	East River.
Manhattan, New York	9,900	Suspension.	East River.
Blackwell's Island, New York	7,450	Cantilever.	East River.
Washington Bridge, New York	2,300	Composite.	Harlem River.
High Bridge, New York	1,460	Stone.	Harlem River.
Niagara, below Falls, New York	1,040	Suspension.	Niagara River.
Niagara	910	Cantilever.	Niagara River.
Freiburg, Germany	880	Suspension.	———
Clifton, England	702	Suspension.	Avon.
Buda-Pest, Hungary	666	Suspension.	Danube.

$50,000 IN GOLD BARS AT THE U. S. MINT IN PHILADELPHIA.

BALLOONS.

In *aërostation*, a bag or hollow pear-shaped vessel, made of varnished silk or other light material, and inflated with some gas or vapor lighter than the air, as hydrogen, carbureted hydrogen, heated air, etc., so as to rise and float in the atmosphere. When filled with gas it is called by way of distinction an AIR-BALLOON (*aérostat*, etc., Fr.; *luftball, luft-schiff*, etc., Ger.); when with heated air a FIRE-BALLOON or MONTGOLFIER B. (*balloon à feu*, etc., Fr.).

In the early days of aërostation, and indeed for some years afterwards, balloons were inflated with hydrogen gas, obtained by the action of sulphuric acid and water on iron filings or small fragments of iron; but this method of filling them ultimately gave place to the cheaper and more convenient supply afforded by the gas-light companies. Of late years, the coal-gas furnished by the gas-works has been generally, if not solely, used for the inflation of balloons.

The principles of ballooning may be referred to the well-known difference in the specific gravity of bodies, and to the physical properties of the atmosphere. Pure hydrogen, weighed at the bottom of the sea, is about 16 times lighter than common air; but when prepared on the large scale, and containing water and other impurities, it is only from 7 to 11 times lighter than the atmosphere. A globe of atmospheric air 1 foot in diameter, under like circumstances, weighs 1-25 lb.; a similar globe of hydrogen (reckoning it only as 6 times lighter than common air), will, therefore, have an ascensional force of 1-30 lb. Now the weight of the body of air which a balloon displaces must exceed the gross weight of the balloon and all its appendages, in order for the latter to ascend in the atmosphere. The difference of the two weights expresses the ascensional force. The aërostatic power of balloons is proportional to their dimensions, in the ratio of the cubes of their diameters. Thus, it appears that a balloon of 60 feet diameter filled with common hydrogen will ascend with a weight of nearly 7,000 lbs., besides the gas case; whilst one of only 1½ feet in diameter will barely float, owing to the less proportionate volume of gas to the weight of the case containing it. In round numbers the buoyancy of a balloon may be reckoned as equal to 1 oz. for every cubic foot of hydrogen it contains, less the weight of the case and appendages. The carbureted hydrogen supplied by the gas-works is much heavier than hydrogen gas, and consequently much less buoyant, for which due allowance must be made. That which possesses the least illuminating power is the lightest, and consequently the best adapted for aërostation.

The fabric of which the cases of air-balloons are made is strong thin silk, covered with an elastic varnish of drying oil or india-rubber, or, what is better, a solution of india-rubber in either chloroform or bisulphide of carbon: the netting is of strong light silk or flaxen cord; and the car, of basket-work. Fire-balloons, on the small scale, are generally made of silver-paper, and are inflated with the fumes of burning alcohol by means of a sponge dipped in that liquid, and suspended just within the mouth of the apparatus.

The following table will prove useful to the amateur aëronaut or balloonist:

TABLE SHOWING THE RELATIONS BETWEEN THE DIAMETERS, SURFACES, AND CAPACITIES OF SPHERES.

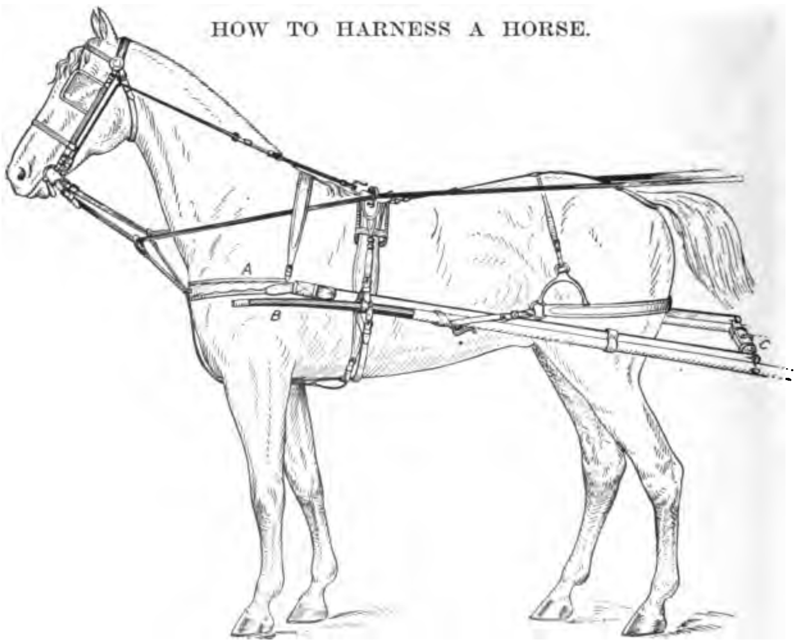
Diameters.	Surfaces.	Cubical content
1	3.141	.523
2	12.567	4.188
3	28.274	14.137
4	50.265	33.51
5	78.54	65.45
10	314.159	523.6
15	706.9	1767.1
20	1256.6	4189
25	1963.5	8181
30	2827	14137
40	5026	33510

Owing to the increasing rarity of the atmosphere as we ascend from the earth's surface, balloon cases are made very much larger than is required to contain the necessary quantity of gas, to allow for its expansion as it rises into a rarer medium. A cubical foot of gas measured at the level of the sea, occupies a space of two feet at an elevation of 3½ miles.—Cooley's Cyclopedia.

AERIAL NAVIGATION.

No motive power machine sufficiently light and powerful to lift itself from the ground and maintain itself in the air for any considerable time has yet been invented. Aerial navigation is therefore at present limited to the use of balloons filled with light gas or hot air. Common coal gas is found to be the cheapest and most generally available gas for ballooning. 1,000 cubic feet of coal gas will lift 35 pounds weight. But hydrogen is the best gas for the purpose. 1,000 cubic feet of hydrogen gas will lift from 60 to 70 pounds. It is the lightest of all substances. It is fifteen times lighter than air, and over eleven thousand times lighter than water. One of the cheapest ways to make hydrogen for balloons is to dissolve zinc in sulphuric acid; the latter is composed of sulphur and hydrogen. When the acid is poured on zinc, the sulphur unites with the metal and sets free the hydrogen, which bubbles up, and is conducted in a pipe to the balloon. Various efforts to propel and steer balloons have been made, by means of propellers turned by hand; also by the use of the electrical storage battery. Balloons are generally made of cotton cloth or silk, varnished with linseed oil, and dissolved rubber is sometimes mixed with the oil.

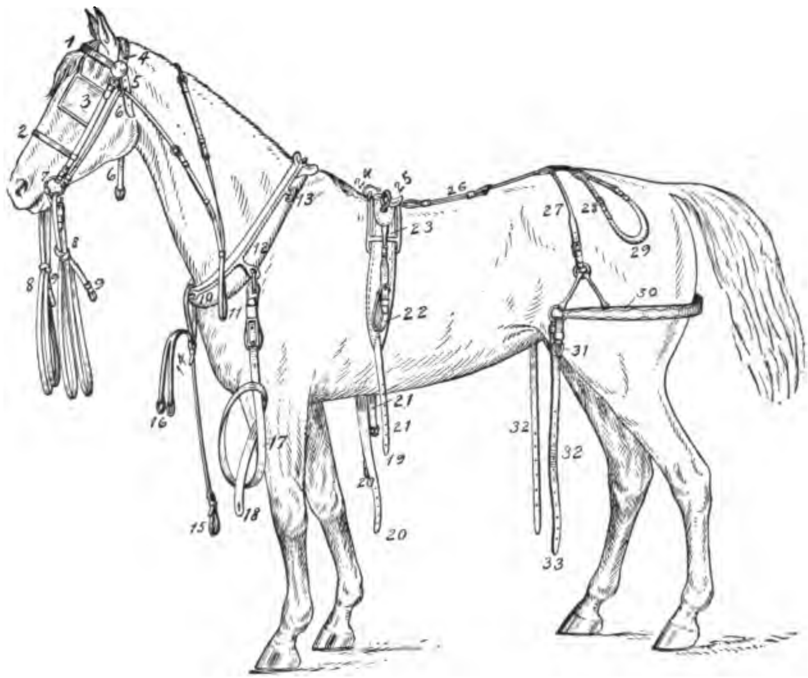
HOW TO HARNESS A HORSE.



Every one should know how to harness a horse, and our second engraving shows the harness placed on a horse with the buckles unfastened and an English collar. The first engraving shows the harness fastened to the shaft and a Dutch collar in place of the English collar. If a Dutch collar is used, slip this over the horse's head, then put on the rest of the harness. If an English collar is used, reverse the collar so that the wide part will be uppermost, and force it over the horse's head, slipping it over the ears, then at the narrow part of the horse's neck turn the collar around so that the narrow part will be uppermost and slip it back on to the horse's shoulders.

If the hames are too tight to allow the collar to slip over the ears, unfasten the hames, and after the collar is on, buckle them once more in front. Next, put on the saddle and breeching, slipping the crupper over the horse's tail by doubling the hair of the tail with the right hand and slipping the crupper over the bunch thus formed, drawing out the hair completely through the crupper. Fasten the inner belly band, first passing it through the loop of the collar strap No. 15 or the martingale, and then pushing the saddle forward as far as the crupper will allow it to go.

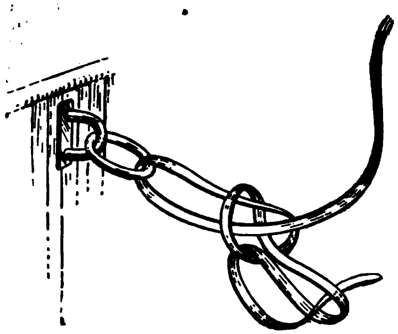
The time has now arrived to bridle the horse. The halter being removed, the horse's head is taken by the forelock with three fingers of the right hand, leaving the forefinger and thumb free, and holding the bridle in the left hand. Pass the head piece of the bridle to the thumb and forefinger of the right hand and slip the bit into the horse's mouth with the left hand, which is then raised to assist the right hand in pulling the head piece back over the horse's ears. Should there be any difficulty in making the horse open his mouth, the bit should be held to his teeth while dangling from the right hand, and then with the thumb and second finger of the left hand press the gums of the horse's mouth at the junction of the lips gently against the teeth. This will quickly force any horse to open his mouth. When the bit is in place, the throat strap is buckled. If a curb bit is used, the



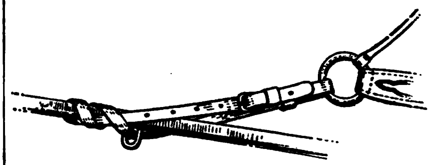
A HORSE HARNESSED WITH THE BUCKLES UNFASTENED.

1, is the brow band; 2, nose band; 3, blinders; 4, head band; 5 and 6, throat strap; 7, bit; 8 and 9, reins; 10, hame fastener; 11, check rein; 12, collar; 13, terrets; 14 and 15, collar straps; 16, martingale; 17 and 18, traces; 19, inner bellyband; 20, outer bellyband; 21, part of inner bellyband; 22, shaft loops; 23, saddle; 24, check-rein hook; 25, saddle terrets; 26, crupper strap; 27, breeching strap; 28 and 29, crupper; 30, breeching; 31 32, and 33, hold-back straps.

curb chain must be twisted until it becomes flat, and then hooked, passing under the jaw of the horse to the curb chain hook in the opposite side



of the bit. The reins are now buckled in the slots at the curb next below the bit ring. Lift up the shafts above the horse's back, then draw up the carriage, slipping the ends of the shafts through the shaft tugs on the sides of



the saddle. The traces are then run through the loop at the side of the shafts and secured to the trace hooks on each side of the whiffletree. After the traces are taut, fasten the breeching or hold-back straps.

PASSPORTS.

Passports are granted and issued by the Secretary of State and by diplomatic representatives of the United States and foreign countries, or by United States Consuls. The fee is $1, and the necessary blank and full information as to the procedure required will be sent on request. Address the Secretary of State, Washington, D. C.

ACCIDENTS IN FACTORIES.

The Annual Report of the Bureau of Labor Statistics of the State of New York for 1899 gives some interesting figures. In April, May, June, 1899, the figures (New York State) are as follows:

ACCIDENTS IN APRIL, MAY, JUNE, 1899.

INDUSTRIES.	FIRMS REPORTING.		Establishments in which acc'ts occurred.	INJURIES.		
	Establishments.	Employees Jun.30		Employees injured in this period.	Proportionate number in one year.	Per ann'm in each 1,000 employed.
Stone and clay products	277	19,764	39	75	300	15.18
Metals, machinery, apparatus	1,321	123,467	260	817	3,268	26.47
Wood	536	31,482	84	145	580	18.42
Leather, rubber, pearl, etc	343	31,169	20	25	100	3.21
Chemicals, oils, explosives	163	13,164	32	145	580	44.06
Pulp, paper, etc	105	8,201	27	87	348	42.43
Printing	576	38,293	58	88	352	9.19
Textiles	327	59,709	53	135	540	9.04
Clothing, millinery, laundering	514	65,220	16	22	88	1.35
Food, tobacco, liquors	474	45,600	66	178	712	15.61
Distribution of water, gas, electricity	26	7,043	11	69	276	37.28
Building industry	269	9,313	25	61	244	26.20
Total	4,931	452,425	691	1,847	7,388	16.33

CAUSE OR AGENT OF ACCIDENTS IN NEW YORK.

Machinery.	
Engines, power transmission, belts, etc..	46
Lifting apparatus	50
Circular saws	102
Presses and stamping machines	135
Other machines and machine tools	319
Total—Machinery	652
Hand tools (saws, axes, etc.)	110
Explosives of all kinds	26
Hot liquids, steam, acids, etc	115
Fall of objects, collapse of structures, etc.	374
Fall of the person	197
Loading, unloading, etc., by hand	54
Vehicles and animals	71
All other	193
Grand Total	1,792
Cause not reported	55

PERIOD OF DISABILITY.

Not over one week:		
Less than one day	45	
One day	85	
From 2 to 7 days	492	
		622
From one week to one month:		
Over 1 to 2 weeks	292	
Over 2 to 3 weeks	169	
Over 3 to 4 weeks	95	
		556
Over 1 month to 2 months		128
Over 2 months (but less than 3 months)		42
Total		1,348
Total days lost	19,980	
Average days lost per capita	15	
Still disabled at time of report (June 30)		27
No time lost (i.e. less than one hour)		161
Time lost not reported		282
Fatal accidents		29
Total		1,847

NATURE OF INJURIES.

Fatal	29
Non-fatal:	
Internal	29
Loss of eye	8
Head and face, except the eye	191
Loss of limb	3
Arms and hands	336
Fingers	638
Legs and feet	381
Other parts of the body or several parts at once	197
Not reported	35
Total	1,847

FATAL ACCIDENTS IN VARIOUS OCCUPATIONS.

	Period.	Rate per 1,000
Railroad brakemen	1900–02	15.8
Gloucester fishermen	1892–00	13.2
Gunpowder manufacture	....–00	10.5
Railroad switchmen and flagmen	1900–02	7.2
Railroad firemen	1900–02	7.2
Railroad engineers	1900–02	6.8
Dynamite manufacturers	....–00	6.7
Railroad conductors	1900–02	6.1
Anthracite coal miners	1892–01	5.6
Bituminous mine laborers	1892–01	4.7
Anthracite mine laborers	1892–01	4.6
Lead and zinc miners of Missouri	1892–01	3.3
Metal miners of Colorado	1896–01	3.2
Copper miners of Montana	1891–00	2.8
Anthracite fire-bosses	1892–01	2.5
Paid firemen in cities	1885–00	2.5
Bituminous coal miners	1892–01	2.2

It is shown by this table that railroad brakemen have the highest fatal accident figure, being respectively 15.8 per 1,000.—*Engineering and Mining Journal.*

ANNUAL FIRE LOSSES IN THE UNITED STATES FOR FOURTEEN YEARS—1890–1903—CHRONICLE FIRE TABLES.

Years.	Aggregate Property Loss.	Aggregate Insurance Loss.	Years.	Aggregate Property Loss.	Aggregate Insurance Loss.
1890	$108,993,792	$65,015,465	1897	$116,354,575	$66,722,145
1891	143,764,967	90,576,918	1898	130,593,905	73,796,080
1892	151,516,098	93,511,936	1899	153,597,830	92,683,715
1893	167,544,370	105,994,577	1900	160,929 805	95,403,650
1894	140,006,484	89,574,699	1901	165,817,810	100,798,645
1895	142,110,233	84,689,030	1902	161,078,040	94,460,525
1896	118,737,420	73,903,800	1903	145,302,155	

Total property loss in the United States in 14 years	$3,371,912,031
Total insurance loss in the United States in 14 years	1,988,644,949
Total property loss, United States and Canada, Jan. 1, 1904, to Sept. 1, 1904	194,172,850

WHAT TO DO IN CASE OF FIRE.

BY CHIEF EDWARD F. CROKER OF THE NEW YORK FIRE DEPARTMENT.

In case of fire immediately send alarm from the nearest alarm box; wait at alarm box until the arrival of the firemen so as to notify them as to the location of the fire. Occupants of premises should endeavor to extinguish fire, if possible, previous to the arrival of the firemen, but do not delay an instant in sending in alarm. Keep cellars and closets under stairways entirely free from rubbish. Always endeavor to keep perfectly cool until the arrival of the Department; do not jump, as the firemen will save you, and are very prompt in reaching the scene of a fire once the alarm is turned in. Keep small chemical fire extinguishers on each floor in all buildings. In case of fire, endeavor to keep all doors shut, thereby avoiding draughts and preventing the rapid extending of fire.

THE COST OF LIVING.

July 1.	Breadstuffs.	Meats.	Dairy and Garden.	Other Food.	Clothing.	Metals.	Miscellaneous.	Total.
1860	20.530	8.973	12.662	8.894	22.439	25.851	15.842	115.191
1861	15.749	7.485	10.813	7.653	21.147	22.500	16.573	101.920
1862	18.057	7.150	13.406	10.987	28.413	23.207	17.290	118.510
1863	26.154	10.115	13.530	16.359	45.679	37.079	24.264	173.180
1864	45.616	15.685	26.053	27.303	73.485	59.192	31.653	278.987
1865	25.404	16.112	18.049	21.057	49.307	38.956	25.551	194.436
1866	31.471	17.153	23.472	20.821	45.377	41.762	27.922	207.978
1867	36.537	14.278	18.418	20.167	38.169	35.426	25.529	188.524
1868	38.416	13.210	23.614	19.720	35.694	27.385	24.786	182.825
1869	29.116	13.181	18.121	16.347	35.309	28.355	24.201	164.630
1870	25.322	14.161	16.112	13.308	31.480	26.612	21.786	148.781
1871	24.809	12.177	20.799	13.823	30.624	27.371	21.907	151.510
1872	22.171	11.055	16.019	14.845	32.427	32.643	21.319	150.479
1873	20.460	10.114	15.629	13.625	29.411	32.298	21.552	143.089
1874	25.657	11.560	19.142	13.678	27.260	25.254	19.582	143.133
1875	24.848	13.287	14.918	14.418	25.318	23.515	18.398	134.702
1876	18.777	10.726	15.912	12.914	21.747	20.452	15.951	116.479
1877	21.812	10.036	11.790	13.321	21.850	15.578	15.160	109.547
1878	15.672	8.181	10.608	11.346	19.836	15.789	14.836	96.268
1879	17.054	8.239	10.253	9.884	20.420	15.149	16.286	97.285
1880	17.461	9.230	12.594	11.539	21.984	18.708	17.139	108.655
1881	20.369	11.381	11.311	11.663	20.982	19.295	16.900	111.901
1882	25.494	13.740	14.685	11.627	21.202	19.832	16.650	123.230
1883	19.018	11.210	12.250	10.726	20.209	18.071	15.764	107.248
1884	17.871	11.172	11.369	9.323	19.014	16.272	14.685	99.706
1885	16.370	9.205	10.872	8.712	17.740	14.132	13.666	90.697
1886	15.311	8.906	10.241	8.570	18.063	14.466	13.669	89.226
1887	15.156	8.667	11.188	9.252	18.174	16.035	15.153	93.624
1888	16.984	9.416	11.849	9.917	17.447	15.366	14.155	95.134
1889	14.351	8.244	9.695	10.912	17.107	14.782	14.600	89.691
1890	14.867	8.036	10.711	9.749	17.264	15.506	15.416	91.549
1891	19.782	9.217	12.455	9.339	16.501	15.107	13.691	96.092
1892	17.426	8.700	10.403	8.733	15.648	14.827	14.252	90.105
1893	14.963	10.135	11.710	9.188	15.871	14.030	14.716	90.613
1894	15.115	9.389	10.394	8.478	13.860	12.015	14.041	83.292
1895	14.765	8.622	9.874	8.689	15.315	11.021	13.233	81.519
1896	10.504	7.058	7.872	8.529	13.602	13.232	13.520	74.317
1897	10.587	7.529	8.714	7.887	13.808	11.642	12.288	72.455
1898	12.783	7.694	9.437	8.826	14.663	11.843	12.522	77.768
1899	13.483	7.988	10.974	9.157	15.021	15.635	12.969	85.227
1900	14.898	8.906	10.901	9.482	16.324	14.834	16.070	91.415
1901	14.904	9.430	11.030	9.086	15.098	15.344	16.617	91.509
1902	20.534	11.628	12.557	8.748	15.533	16.084	16.826	101.910
1903	17.473	9.269	13.083	9.186	17.136	16.544	16.765	99.456
1904	18.244	9.033	10.648	10.406	16.514	15.428	16.919	97.192

NOTE.—Breadstuffs include many quotations of wheat, corn, oats, rye, and barley, besides beans and peas; meats include live hogs, beef, sheep, and many provisions, lard, tallow, etc.; dairy and garden products include eggs, vegetables and fruits; other foods include fish, liquors, condiments, sugar, rice, tobacco, etc.; clothing, includes the raw material of each industry, and many quotations of woolen, cotton and other textile goods, as well as hides, leather, boots and shoes; metals include various quotations of pig iron, and partially manufactured and finished products, as well as minor metals, coal, and petroleum. The miscellaneous class embraces many grades of hard and soft lumber, lath, brick, lime, glass, turpentine, hemp, linseed-oil, paints, fertilizers, and drugs.—*Dun's Review.*

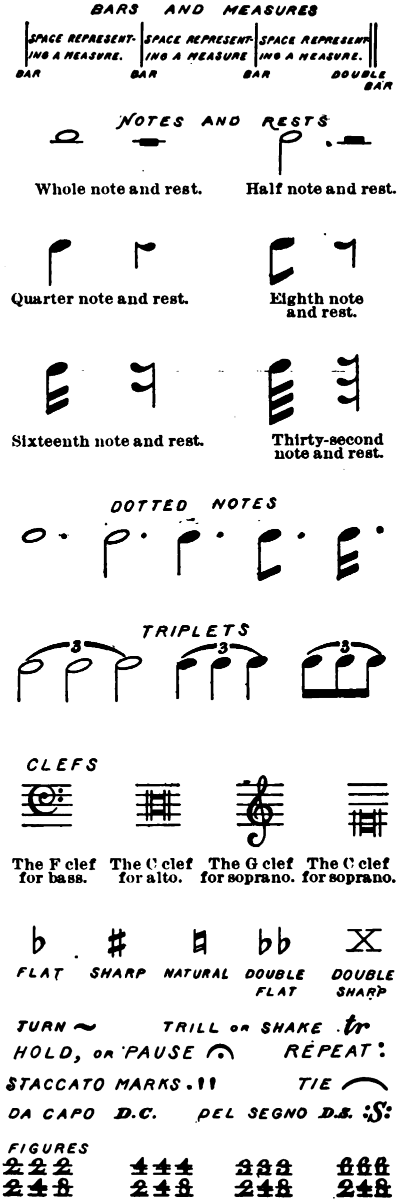
DISTILLED SPIRITS, WINES, AND MALT LIQUORS, QUANTITIES CONSUMED.

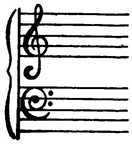
CONSUMPTION PER CAPITA IN THE UNITED STATES.

Year Ending June 30—	Distilled Spirits Consumed.				Wines Consumed.			Malt Liquors Consumed.			Total Consumption of Wines and Liquors.	Total Consumption per Capita.			
	Domestic.[1]		Imported for Consumption.	Total.	Domestic.[2]	Imported for Consumption.	Total	Domestic.[2]	Imported for Consumption.	Total.		Of Distilled Spirits.	Of wines	Of Malt Liquors.	Of all Liquors and wines
	From Fruit.	All Other.													
	Proof Gallons.	Proof Gallons.	Proof Gallons.	Proof Gallons.	Proof Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	Gallons.	P. Galls.	Galls.	Galls.	Galls.
1881	1,701,206	67,426,000	1,479,875	70,607,081	18,931,819	5,231,106	24,162,925	442,947,664	1,164,505	444,112,169	538,882,175	1.38	0.47	8.65	10.50
1890	1,508,130	84,760,240	1,561,192	87,829,562	23,896,108	5,060,873	28,956,981	853,075,734	2,716,601	855,792,335	972,578,878	1.40	.46	13.67	15.53
1900	1,386,361	94,156,023	1,705,998	97,248,382	26,492,491	3,935,000	30,427,491	1,218,183,252	3,316,908	1,221,500,160	1,349,176,033	1.27	.40	16.01	17.68
1903	1,214,068	113,598,545	2,439,535	117,252,148	32,631,154	6,088,201	38,719,355	1,445,675,414	4,204,538	1,449,879,952	1,605,851,455	1.46	.48	18.04	19.98

[1] Since 1886 includes domestic spirits exported and returned. [2] Product less domestic exports.

MUSICAL SIGNS.

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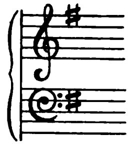
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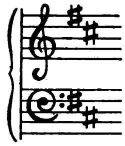
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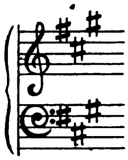

Key of A.


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RELIGIONS OF THE WORLD.

Roman Catholics.......	216,000,000
Protestants	137,000,000
Greek, Armenian and Abyssinian Churches..	95,000,000
Total of Christians	448,000,000
Buddhists and Brahmins	672,000,000
Mohammedans	200,000,000
Jews	7,000,000
Other creeds...........	125,000,000
Total non-Christians	1,004,000,000

THE CHRISTIAN ADVOCATE'S TABLE OF DENOMINATIONS.

Denominations.	Summary for 1903.		
	Ministers.	Churches.	Communicants.
Adventists (6 bodies)	1,556	2,377	89,476
Baptists (13 bodies)	35,829	51,492	4,725,775
Brethren (River) (3 bodies)	151	108	3,605
Brethren (Plymouth) (4 bodies)	......	314	6,661
Catholics (8 bodies)	13,422	11,185	9,891,869
Catholic Apostolic	95	10	1,491
Chinese Temples	......	47	....
Christadelphians	......	63	1,277
Christian Connection	1,348	1,340	101,597
Christian Catholics (Dowie)	104	110	40,000
Christian Missionary Association	10	13	754
Christian Scientists	1,118	559	60,283
Church of God (Winebrennarian)	460	580	38,000
Church of the New Jerusalem	143	144	7,969
Communistic Societies (6 bodies)	......	22	3,084
Congregationalists	6,213	5,891	659,704
Disciples of Christ	6,567	11,157	1,235,798
Dunkards (4 bodies)	3,231	1,171	115,194
Evangelical (2 bodies)	1,415	2,642	162,998
Friends (4 bodies)	1,354	1,093	116,555
Friends of the Temple	4	4	340
German Evangelical Protestant	100	155	20,000
German Evangelical Synod	945	1,213	209,791
Jews (2 bodies)	301	570	143,000
Latter-Day Saints (2 bodies)	1,525	1,324	342,072
Lutherans (22 bodies)	7,343	12,275	1,715,910
Swedish Evangelical Miss. Covenant	291	307	33,400
Mennonites (12 bodies)	1,138	673	59,892
Methodists (17 bodies)	39,634	57,572	6,192,494
Moravians	127	115	16,095
Presbyterians (12 bodies)	12,393	15,452	1,661,522
Protestant Episcopal (2 bodies)	5,150	6,867	782,543
Reformed (3 bodies)	1,919	2,491	390,578
Salvation Army	2,361	696	25,009
Schwenkfeldians	3	4	306
Social Brethren	17	20	913
Society for Ethical Culture	......	4	1,500
Spiritualists	......	334	45,030
Theosophical Society	......	70	1,900
United Brethren (2 bodies)	2,368	4,861	280,114
Unitarians	540	452	71,000
Universalists	734	786	53,538
Independent Congregations	54	156	14,126
Grand total in 1903	149,963	196,719	29,323,158
Grand total in 1902	147,732	194,072	28,840,699

PART II.

CHAPTER I.

GEOMETRICAL CONSTRUCTIONS.

GEOMETRICAL FIGURES.

1. Acute Angle.—An acute angle is less than a right angle, or less than 90 degrees.

2. Alternate Angles.—The internal angles made by two lines with a third, on opposite sides of it. If the two lines are parallel, the alternate angles are equal. If the parallels *AB*, *CD*, be cut by the line *EF*, the angles *AGH*, *GHD*, as also the angles *BGH* and *GHC*, are called alternate angles.

3. Arc.—Any part of the circumference of a circle or other curve; a segment of a circle.

4, 5, 6, and 7. Conic Sections.—Formed by the intersections of cones and planes. The conic sections are the ellipse, parabola, and hyperbola. If the section be taken parallel to the base of the cone its outline will form a perfect circle. If the section be taken parallel to one side of the cone it will in outline have the form of a parabola (6). If the section be taken parallel to the axis of the cone its outline will have the form of a hyperbola (7). Any other section through the cone will in outline have the form of an ellipse (5).

8. Chord.—A right line marking the extremities of the arc of a circle.

9. Circle.—1. In geometry, a plane figure, comprehended by a single curve line, called its circumference, every part of which is equally distant from a point called the center. Of course all lines drawn from the center to the circumference, or periphery, are equal to each other. 2. In popular use, the line that comprehends the figure, the plane or surface comprehended, and the whole body or solid matter of a round substance, are denominated a circle; a ring; an orb; the earth.

10. Curve.—A curve line is one which may be cut by a right line in more points than one. A curve line is that which is neither a straight line nor composed of straight lines.

11. Cube.—A regular, solid body with six equal square sides.

12. Cylinder.—A solid body supposed to be generated by the rotation of a parallelogram round one of its sides; or a long, circular body, of uniform diameter, and its extremities forming equal parallel circles.

13. Diagonal.—The line extending from one angle to another of a quadrilateral or multilateral figure, and dividing it into two parts.

14. Diagram.—A figure, draught, or scheme delineated for the purpose of demonstrating the properties of any figure, as a square, triangle, circle, etc.

15. Diameter.—A right line passing through the center of a circle, or other curvilinear figure, terminated by the curve, and dividing the figure symmetrically into two equal parts.

16. Ellipse.—In conic sections, a figure formed by the intersection of a plane and cone when the plane passes obliquely through the opposite sides of the cone.

17. Equilateral Triangle.—A triangle having all three sides equal.

18. Hexagon.—A plane figure of six sides and six angles. If the sides and angles are equal, it is a regular hexagon. The cells of honey-comb are hexagons, and it is remarkable that bees instinctively form their cells of this figure, which fills any given space without any interstice or loss of room.

19. Hypothenuse.—The subtense or longest side of a right-angled triangle, or the line that subtends the right angle.

20. Rectangular Triangle.—If one of the angles of a triangle is a right angle, the triangle is rectangular.

21. Right Angle.—A right angle is one formed by a right line falling on another perpendicularly, or an angle of 90 degrees, making the quarter of a circle.

22. Isosceles Triangle.—If two of the sides only are equal in a triangle it is an isosceles or equicrural triangle.

23. Oblique Line.—An oblique line is one that, falling on another, makes oblique angles with it.

24. Obtuse Angle.—An angle greater than a right angle, or containing more than 90 degrees.

25. Scalene Triangle.—One in which all the three sides are unequal.

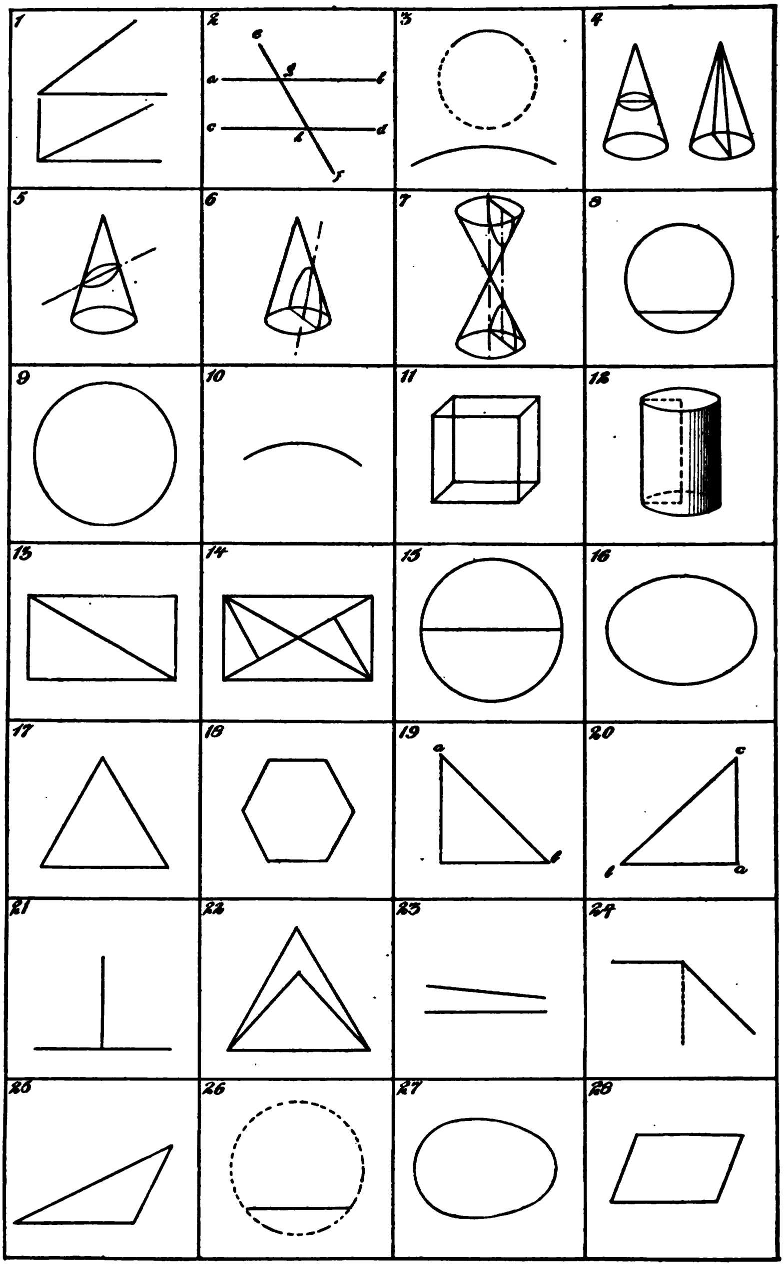
26. Secant.—The secant of a circle is a line drawn from the circumference on one side to a point without the circumference on the other.

27. Oval.—A body or figure in the shape of an egg, or of an ellipse.

28. Parallelogram.—1. In geometry, a right-lined quadrilateral figure, whose opposite sides are parallel, and consequently equal. 2. In common use, this word is applied to quadrilateral figures of more length than breadth.

29. Sector.—A part of a circle comprehended between two radii and the included arc; or a mixed triangle, formed by two radii and the arc of a circle.

30. Parallelopiped.—A regular solid comprehended under six parallelograms, the opposite ones of which are similar, parallel, and equal to each other; or it is a prism whose base is a parallelogram. It is always triple to a pyramid of the same base and height. Or a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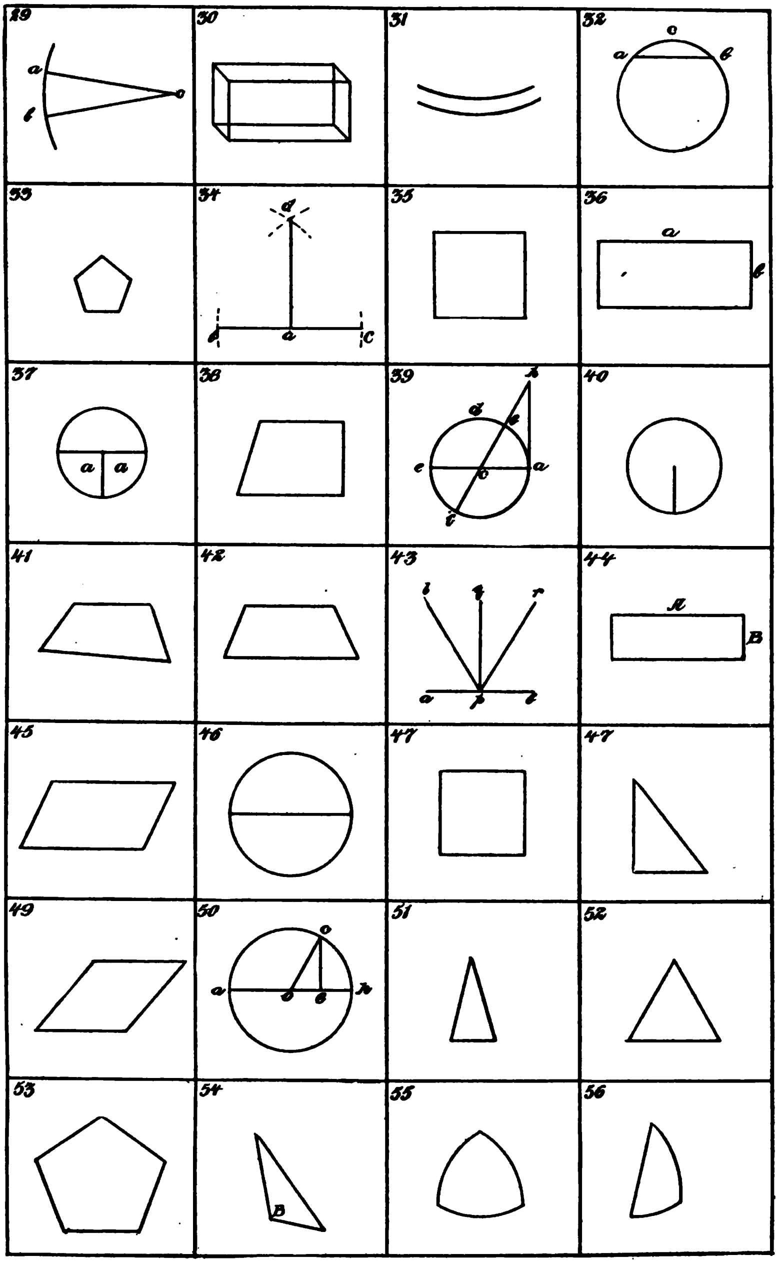


parallelopiped is a solid figure bounded by six faces, parallel to each other, two and two.

31. PARALLEL LINES.—One line is parallel to another, when the lines are at an equal distance apart throughout the whole length.

32. SEGMENT OF A CIRCLE.—That part of the circle contained between a chord and an arc of that circle, or so much of the circle as is cut off by the chord. The segment of a sphere is a part cut off by a plane.

33. PENTAGON.—A plane figure having five angles, and consequently five sides.

34. PERPENDICULAR.—In geometry, a line falling at right angles on another line, or making equal angles with it on each side. Thus if the straight line AD, falling on the straight line BC, make the angles BAD, DAC equal to one another, AD is called a perpendicular to BC.

35. QUADRANGLE.—A plane figure having four angles, and consequently four sides.

36. RECTANGLE.—A four-sided figure having only right angles. A right-angled parallelogram.

37. QUADRANT.—The quarter of a circle or of the circumference of a circle.

38. QUADRILATERAL.—Having four sides, and consequently four angles.

39. TANGENT.—In the figure, let AH be a straight line drawn touching the circle ADE at A, one extremity of the arc AB, and meeting the diameter IB produced, which passes through the other extremity B to the point H; then AH is the tangent of the arc AB, or of the angle ACB, of which AB is the measure.

40. RADIUS.—A right line drawn or extending from the center of a circle to the periphery; the semidiameter of the circle. In trigonometry, the radius is equal to the sine of 90 degrees.

41. TRAPEZIUM.—A plane figure contained under four right lines, of which no two are parallel.

42. TRAPEZOID.—A plane, four-sided figure, having two of the opposite sides parallel to each other.

43. REFLECTION.—In the figure, let AB represent a smooth polished surface, or mirror, and suppose a ray of light proceeding in the direction LP to impinge on the surface at P, and to be reflected from it in the direction PR. From P draw PQ perpendicular to AB, then the angle LPQ is called the angle of incidence, and QPR the angle of reflection.

44. SUPERFICIES. A superficies consists of length and breadth; as, the superficies of a plate or of a sphere. Superficies is rectilinear, curvilinear, plane, convex, or concave.

45. RHOMBOID.—A figure having some resemblance to a rhomb; or a quadrilateral figure whose opposite sides and angles are equal, but which is neither equilateral nor equiangular.

46. SEMICIRCLE.—The half of a circle; the part of a circle comprehended between its diameter and half of its circumference.

47. SQUARE.—A rectilinear figure having four equal sides and four right angles.

48. RECTILINEAR TRIANGLE.—One in which the three lines or sides are all right lines, as distinguished from curvilinear triangle.

49. RHOMB, RHOMBUS.—An oblique-angled, equilateral parallelogram, or a quadrilateral figure whose sides are equal and the opposite sides parallel, but the angles unequal, two of the angles being obtuse and two acute.

50. SINE.—In the circle ACH, let AOH be a diameter, and let CE be perpendicular thereto; then shall CE be the sine of the arc CH, or of the angle COH, and of its supplement COA. The sine of a quadrant, or of a right angle, is equal to the radius. The sine of any arc is half the chord of twice that arc.

51. ACUTE-ANGLED TRIANGLE.—One having all three of its angles acute.

52. AN EQUILATERAL TRIANGLE.—One having all the three sides equal.

53. POLYGON.—A plane figure of many angles, and consequently of many sides; particularly, one whose perimeter consists of more than four sides.

54. OBTUSANGULAR TRIANGLE.—If one of the angles of a triangle is obtuse, the triangle is called obtusangular or amblygonous.

55. CURVILINEAR AND SPHERICAL TRIANGLES.—If the three sides of a triangle are all curves, the triangle is said to be curvilinear. If the sides are all arcs of great circles of the sphere, the triangle is said to be spherical.

56. MIXTILINEAR TRIANGLE.—If some of the sides of a triangle are right and others curve, the triangle is said to be mixtilinear.

GEOMETRICAL CONSTRUCTIONS.*

1.

To divide a given line $A\ B$ into two equal parts; and to erect a perpendicular through the middle.

With the end A and B as centers, draw the dotted circle arcs with a radius greater than half the line. Through the crossings of the arcs draw the perpendicular $C\ D$, which divides the line into two equal parts.

2.

From a given point C on the line $A\ B$, erect a perpendicular $C\ D$.

With C as a center, draw the dotted circle arcs at A and B equal distances from C. With A and B as centers, draw the dotted circle arcs at D. From the crossing D draw the required perpendicular $D\ C$.

3.

From a given point C at a distance from the line $A\ B$, draw a perpendicular to the line.

With C as a center, draw the dotted circle arc so that it cuts the line at A and B. With A and B as centers, draw the dotted cross arcs at D with equal radii. Draw the required perpendicular through C and crossing D.

4.

At the end of A to a given line $A\ B$, erect a perpendicular $A\ C$.

With the point D as a center at a distance from the line, and with $A\ D$ as radius, draw the dotted circle arc so that it cuts the line at E through E and D, draw the diameter $E\ C$; then join C and A, which will be the required perpendicular.

5.
Through a given point *C* at a distance from the line *A B*, draw a line *C D* parallel to *A B*.
With *C* as a center, draw the dotted arc *E D*, with *E* as a center, draw through *C* the dotted arc F. C. With the radius *F C* and *E* as a center, draw the cross arc at *D*. Join *C* with the cross at *D*, which will be the required parallel line.

6.
On a given line *A B* and at the point *B*, construct an angle equal to the angle *C D E*.
With *D* as a center, draw the dotted arc *C E;* and with the same radius and *B* as a ce. ter, draw the arc *G F;* then make *G F* equal to *C E;* then join *B F*, which will form the required angle, $F B G = C D E$.

7.
Divide the angle *A C B* into two equal parts.
With *C* as a center, draw the dotted arc *D E;* with *D* and *E* as centers, draw the cross arcs at *F* with equal radii. Join *C F*, which divides the angle into the required parts.
Angles $A C F = F C B = \frac{1}{2}(A C B)$.

8.
Divide an angle into two equal parts, when the lines do not extend to a meeting point.
Draw the lines *C D* and *C E* parallel, and at equal distances from the lines *A B* and *F G*. With *C* as a center, draw the dotted arc *B G;* and with *B* and *G* as centers, draw the cross arcs *H*. Join *C H*, which divides the angle into the required equal parts.

9.
To construct a parallelogram, with the given sides *A* and *B* and angle *C*.
Draw the base line *D E*, and make the angle $F D E = C$; lines $D E = B$ and $D F = A$; complete the parallelogram by cross arcs at *G*, and the problem is thus solved.

10.
To divide the line *A B* in the same proportion of parts as *A C*.
Join *C* and *B*, and through the given divisions 1, 2, and 3 draw lines parallel with *C B*, which solves the problem.

11.
To find the center of a circle which will pass through three given points *A*, *B*, and *C*.
With *B* as a center, draw the arc *D E F G;* and with the same radius and *A* as a center, draw the cross arcs *D* and *F;* also with *C* as a center, draw the cross arcs *E* and *G*. Join *D* and *F*, and also *E* and *G*, and the crossing *o* is the required center of the circle.

12.
To construct a square upon a given line *A B*.
With *A B* as radius and *A* and *B* as centers, draw the circle arcs*A E D* and *B E C*. Divide the arc *B E* in two equal parts at *F*, and with *E F* as radius, and *E* as center, draw the circle *C F D*. Join *A* and *C B* and *D*, *C* and *D*, which completes the required square.

13.
Through a given point *A* in a circumference, draw a tangent to the circle.
Through a given point *A* and center *C*, draw the line *B C*. With *A* as a center, draw the circle arcs *B* and *C;* with *B* and *C* as centers, draw the cross arcs *D* and *E;* then join *D* and *E*, which is the required tangent.

14.
From a given point *A* outside of a circumference, draw a tangent to the circle.
Join *A* and *C*, and upon *A C* as a diameter draw the half circle *A B C*, which cuts the given circle at *B*. Join *A* and *B*, which is the required tangent.

15.
To draw a circle with a given radius *R*, that will tangent the circle *A B C* at *C*.
Through the given point *C*, draw the diameter *A C* extended beyond *D;* from *C* set off the given radius *R* to *D;* then *D* is the center of the required circle, which tangents the given circle at *C*.

16.
To draw a circle with a given radius *R*, that will tangent two given circles.
Join the centers *A* and *B* of the given circles Add the given radius *R* to each of the radii of the given circle, and draw the cross arcs *C*, which is the center of the circle required to tangent the other two.

17.
To draw a tangent to two circles of different diameters.
Join the centers *C* and *c* of the given circles, and extend the line to *D;* draw the radii *A C* and *a c* parallel with one another. Join *A a*, and extend the line to *D*. On *C D* as a diameter, draw the half circle *C e D;* on *c D* as a diameter, draw the half circle *c f D;* then the crossings *e* and *f* are the tangenting points of the circles.

18.
To draw a tangent between two circles.
Join the centers *C* and *c* of the given circles; draw the dotted circle arcs, and join the crossing *m*, *n*, which line cuts the center line at *a*. With *a C* as a diameter, draw the half circle *a f C;* and with *a c* as a diameter, draw the half circle *c e a;* then the crossings *e* and *f* are the tangenting points of the circles.

19.
With a given radius *r*, draw a circle that will tangent the given line *A B* and the given circle *C D*.
Add the given radius *r* to the radius *R* of the circle, and draw the arc *c d*. Draw the line *c e* parallel with and at a distance *r* from the line *A B*. Then the crossing *c* is the center of the required circle that will tangent the given line and circle.

20.
To find the center and radius of a circle that will tangent the given circle *A B* at *C*, and the line *D E*.
Through the given point *C*, draw the tangent *G F;* bisect the angle *F G E;* then *o* is the center of the required circle that will tangent *A B* at *C*, and the line *D E*.

21.
To find the center and radius of a circle that

will tangent the given line *A B* at *C*, and the circle *D E*.

Through the point *C*, draw the line *E F* at right angles to *A B;* set off from *C* the radius *r* of the given circle. Join *G* and *F*. With *G* and *F* as centers draw the arc crosses *m* and *n*. Join *m n*, and where it crosses the line *E F* is the center for the required circles.

22.
To find the center and radius of a circle that will tangent the given line *A B* at *C*, and the circle *D E*.

From *C*, erect the perpendicular *C G;* set off the given radius *r* from *C* to *H*. With *H* as a center and *r* as radius, draw the cross arcs on the circle. Through the cross arcs draw the line *I G;* then *G* is the center of the circle arc *F I C*, which tangents the line at *C* and the circle at *F*.

23.
Between two given lines, draw two circles that will tangent themselves and the lines.

Draw the center line *A B* between the given lines; assume *D* to be the tangenting point of the circles; draw *D C* at right angles to *A B*. With *C* as center and *C D* as radius, draw the circle *E D F*. From *E*, draw *E m* at right angles to *E F*; and from *F* draw *F m* at right angles to *F E*; then *m* and *n* are the centers for the required circles.

24.
Draw a circle that will tangent two given lines *A B* and *C D* inclined to one another and the one tangenting point *E* being given.

Draw the center line *G F*. From *E*, draw *E F* at right angles to *A B;* then *F* is the center of the circle required.

25.
Draw a circle that will tangent two lines and go through a given point *C* on the line *F C*, which bisects the angle of the lines.

Through *C* draw *A B* at right angles to *C F;* bisect the angles *D A B* and *E B A*, and the crossing on *C F* is the center of the required circle.

26.
To draw a *cyma*, or two circle arcs that will tangent themselves, and two parallel lines at given points *A* and *B*.

Join *A* and *B;* divide *A B* into four equal parts and erect perpendiculars. Draw *A m* at right angles from *A*, and *B n* at right angles from *B;* then *m* and *n* are the centers of the circle arcs of the required *cyma*.

27.
To draw a *talon*, or two circle arcs, that will tangent themselves, and meet two parallel lines at right angles in the given points *A* and *B*.

Join *A* and *B;* divide *A B* into four equal parts and erect perpendiculars; then *m* and *n* are the centers of the circle arcs of the required *talon*.

28.
To plot out a circle arc without recourse to its center, but its chord *A B* and height *h* being given.

With the chord as radius, and *A* and *B* as centers, draw the dotted circle arcs *A C* and *B D*. Through the point *O* draw the lines *A O o* and *B O o*. Make the arcs *C o* = *A o* and *D o* = *B o*. Divide these arcs into any desired number of equal parts, and number them as shown on the illustration. Join *A* and *B* with the divisions, and the crossings of equal numbers are points in the circle arc.

29.
To find the center and radius of a circle that will tangent the three sides of a triangle.

Bisect two of the angles in the triangle, and the crossing *C* is the center of the required circle.

30.
To inscribe an equilateral triangle in a circle.

With the radius of the circle and center *C* draw the arc *D F E;* with the same radius, and *D* and *E* as centers, set off the points *A* and *B*. Join *A* and *B*, *B* and *C*, *C* and *A*, which will be the required triangle.

31.
To inscribe a square in a given circle.

Draw the diameter *A B*, and through the center erect the perpendicular C D, and complete the square as shown in the illustration.

32.
To describe a square about a given circle.

Draw the diameters *A B* and *C D* at right angles to one another; with the radius of the circle, and *A*, *B*, *C*, and *D* as centers, draw the four dotted half circles which cross one another in the corners of the square, and thus complete the problem.

33.
To inscribe a *pentagon* in a given circle.

Draw the diameter *A B*, and from the center *C* erect the perpendicular *C D*. Bisect the radius *A C* at *E;* with *E* as center, and *D E* as radius, draw the arc *D E*, and the straight line *D F* is the length of the side of the pentagon.

34.
To construct a *pentagon* on a given line *A B*.

From B erect *B C* perpendicular to and half the length of *A B;* join *A* and *C* prolonged to *D;* with *C* as a center and *C B* as radius, draw the arc *B D;* then the chord *B B* is the radius of the circle circumscribing the pentagon. With *A* and *B* as centers, and *B D* as radius, draw the cross *O* in the center.

35.
To construct a pentagon on a given line *A B* without resort to its center.

From *B* erect *B o* perpendicular and equal to *A B;* with *C* as center and *C o* as radius, draw the arc *D o;* then *A D* is the diagonal of the pentagon. With *A D* as radius and *A* as center, draw the arc *D E;* and with *E* as center and *A B* as radius, finish the cross *E*, and thus complete the pentagon.

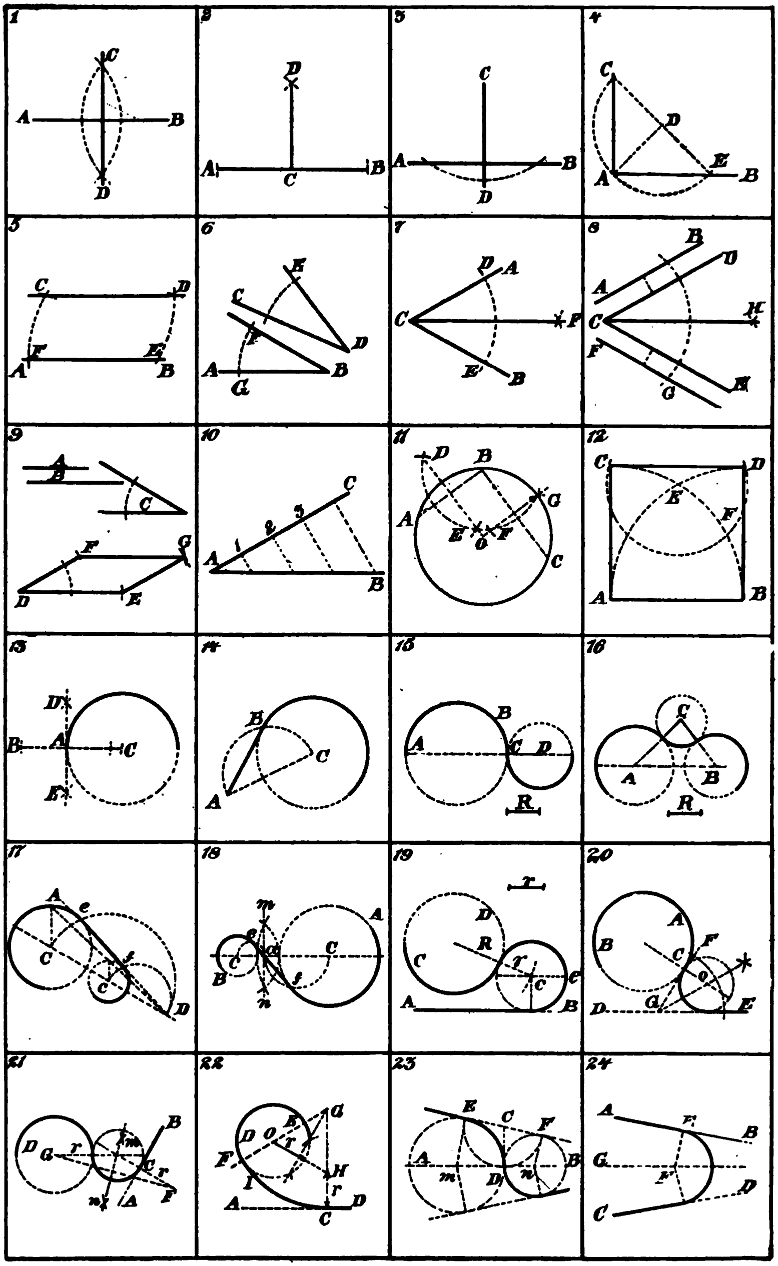
36.
To construct a *hexagon* in a given circle.

The radius of the circle is equal to the side of the hexagon.

37.

To construct a Heptagon.

The appotem *a* in a hexagon is the length of the side of the heptagon.



Set off A B equal to the radius of the circle; draw a from the center C at right angles to A B; then a is the required side of the heptagon.

38.
To construct an *octagon* on the given line A B.
Prolong A B to C. With B as center and A B as radius, draw the circle A F D E C; from B, draw B I at right angles to A B; divide the angles A B D and D B C each into two equal parts; then B E is one side of the octagon. With A and E as centers, draw the arcs H K E and A K I, which determine the points H and I, and thus complete the octagon as shown in the illustration.

39.
To cut off the corners of a square, so as to make of it a regular *octagon*.
With the corners as centers, draw circle arcs through the center of the square to the side, which determines the cut-off.

40.
The area of a regular polygon is equal to the area of a triangle whose base is equal to the sum of all the sides, and the height a equal to the appotem of the polygon.
The reason of this is that the area of two or more triangles A B C and A D C having a common or equal base b and equal height h are alike.

41.
To construct any regular *polygon* on a given line A B without resort to its center.
Extend A B to C and, with B as center, draw the half circle A D B. Divide the half circle into as many parts as the number of sides in the polygon, and complete the construction as shown on the illustration.

42.
To construct an isometric ellipse by compasess and six circle arcs.
Divide O A and O B each into three equal parts; draw the quadrant A C. From C, draw the line C c through the point 1. Through the points 2 draw d e at an angle of 45° with the major axis. Then 2 is the center for the ends of the ellipse; e is the center for the arc d c; and C is the center for the arc c f.

43.
To construct a Hyperbola by plotting,

Having given the transverse axis B C, vertexes A a, and foci f f'. Set off any desired number of parts on the axis below the focus, and number them 1, 2, 3, 4, 5, etc. Take the distance a 1 as radius, and, with f' as center, strike the cross 1 with f' $1=a$ 1. With the distance A 1, and the focus f as center, strike the cross 1 with the radius F $1=A$ 1, and the cross 1 is a point in the hyperbola.

44.
To draw an Hyperbola by a pencil and a string,
Having given the transverse axis B C, foci f' and f, and the vertexes A and a. Take a rule and fix it to a string at e; fix the other end of the string at the focus f. The length of the string should be such that when the rule R is in the position $f'C$, the loop of the string should reach to A; then move the rule on the focus f', and a pencil at P, stretching string, will trace the hyperbola.

45.
To construct a Parabola by plotting,
Having given the axis, vertex, and focus of the parabola. Divide the transverse axis into any desired number of parts 1, 2, 3, etc., and draw ordinates through the divisions; take the distance A 1, and set it off on the 1st ordinate from the focus f to a, so that A $1=f$ a. Repeat the same operation with the other ordinates—that is, set off the distance A 5 from f to e, so that A $5=f$ e; and so the parabola is constructed.

46.
To draw a Parabola with a pencil and a string,

Having given the two axes, vertex, and focus of the parabola. Take a square c d e, and fix to it a string at c; fix the other end of the string at the focus f. The length of the string should be such that when the square is in the position of the axis A f, the string should reach to the vertex A. Move the square along B B, and the pencil P will describe the parabola.

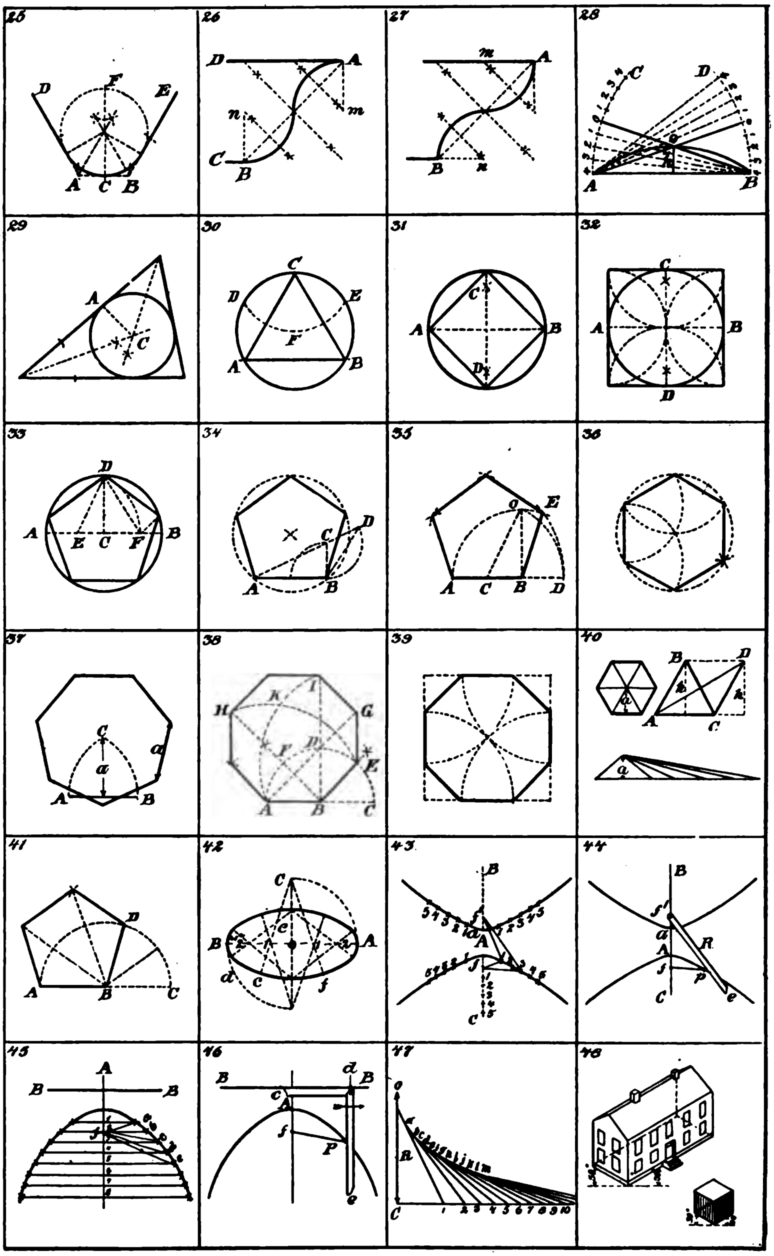
47.
Shield's anti-friction curve.
R represents the radius of the shaft, and C 1, 2, 3, etc., is the center line of the shaft. From o, set off the small distance o a; and set off a $1=R$. Set off the same small distance from a to b, and make b $2=R$. Continue in the same way with the other points, and the anti-friction curve is thus constructed.

48.
Isometric Perspective.
This kind of perspective admits of scale measurements the same as any ordinary drawing, and gives a clear representation of the object. It is easily learned. All horizontal rectangular lines are drawn at an angle of 30°.
All circles are ellipses of proportion, as shown in No. 42, on the following page.

49.
To construct an ellipse.
With a as a center, draw two concentric circles with diameters equal to the long and short axes of the desired ellipse. Draw from o any number of radii, A, B, etc. Draw a line B b' parallel to n and b b' parallel to m, then b is a point in the desired ellipse.

50.
To draw an ellipse with a string.
Having given the two axes, set off from c half the great axis at a and b, which are the two focuses of the ellipse. Take an endless string as long as the three sides in the triangle a b c, fix two pins or nails in the focuses, one in a and one in b, lay the string around a and b, stretch it with a pencil d, which then will describe the desired ellipse.

51.
To draw an ellipse by circle arcs.
Divide the long axis into three equal parts, draw the two circles, and where they intersect one another are the centers for the tangent arcs of the ellipse as shown by the figure.



52.

To draw an ellipse by circle arcs.

Given the two axes, set off the short axis from A to b, divide b into three equal parts, set off two of these parts from o towards c and c which are the centers for the ends of the ellipse. Make equilateral triangles on $c\,c$, when $e\,e$ will be the centers for the sides of the ellipse. If the long axis is more than twice the short one, this construction will not make a good ellipse.

53.

To construct an ellipse.

Given the two axes, set off half the long axis from c to $f\,f$, which will be the two focuses in the ellipse. Divide the long axis into any number of parts, say a to be a division point. Take $A\,a$ as radius and f as center and describe a circle arc about b, take $a\,B$ as radius and f as center describe another circle arc about b, then the intersection b is a point in the ellipse, and so the whole ellipse can be constructed.

54.

To draw an ellipse that will tangent two parallel lines in A and B.

Draw a semicircle on $A\,B$, draw ordinates in the circle at right angle to $A\,B$, the corresponding and equal ordinates for the ellipse to be drawn parallel to the lines, and thus the elliptic curve is obtained as shown by the figure.

55.

To construct a cycloid.

The circumference $C = 3.14\ D$. Divide the rolling circle and base line C into a number of equal parts, draw through the division point the ordinates and abscissas, make $a\ a' = 1\ d$, $b\ b' = 2'e$, $c\ c = 3\ f$, then $a\ b'$ and c' are points in the cycloid. In the *Epicycloid* and *Hypocycloid* the abscissas are circles and the ordinates are radii to one common center.

56.

Evolute of a circle.

Given the pitch p, the angle v, and radius r. Divide the angle v into a number of equal parts, draw the radii and tangents for each part, divide the pitch p into an equal number of equal parts, then the first tangent will be one part, second two parts, third three parts, etc., and so the *Evolute* is traced.

57.

To construct a spiral with compasses and four centers.

Given the pitch of the spiral, construct a square about the center, with the four sides together equal to the pitch. Prolong the sides in one direction as shown by the figure, the corners are the centers for each arc of the external angles.

58.

To construct a Parabola.

Given the vertex A, axis x, and a point P. Draw $A\ B$ at right angle to x, and $B\ P$ parallel to x, divide $A\ B$ and $B\ P$ into an equal number of equal parts. From the vertex A draw lines to the divisions on $B\ P$, from the divisions on $A\ B$ draw the ordinates parallel to x, the corresponding intersections are points in the *parabola*.

59.

To construct a Parabola.

Given the axis of ordinate B, and vertex A. Take A as a center and describe a semicircle from B which gives the focus of the *parabola* at f. Draw any ordinate y at right angle to the abscissa $A\ x$, take a as radius and the focus f as a center, then intersect the ordinate y, by a circle-arc in P which will be a point in the *parabola*. In the same manner the whole Parabola is constructed.

60.

To draw an arithmetic spiral.

Given the pitch p and angle v, divide them into an equal number of equal parts, say 6; make 0 1 = 0 1, 0 2 = 0 2, 0 3 = 0 3, 0 4 = 0 4, 0 5 = 0 5, and 0 6 = the pitch p; then join the points 1, 2, 3, 4, 5 and 6, which will form the spiral required.

THE CIRCLE.

Notation of Letters.

d = diameter of the circle.
r = radius of the circle.
p = periphery or circumference.
a = area of a circle or part thereof.
b = length of a circle arc.
c = chord of a segment, length of.
h = height of a segment.
s = side of a rectangular polygon
v = center angle.
w = polygon angle.

All measures must be expressed by the same unit.

FORMULAS FOR THE CIRCLE.

Periphery or Circumference.

$$p = \pi\ d = 3.14d.$$

$$p = 2\pi\ r = 6.28r.$$

$$p = 2\sqrt{\pi\ a} = 3.54\sqrt{a}.$$

$$p = \frac{2a}{r} = \frac{4a}{d}.$$

Diameter and Radius.

$$d = \frac{p}{\pi} = \frac{p}{3.14}.$$

$$r = \frac{p}{2\pi} = \frac{p}{6.28}.$$

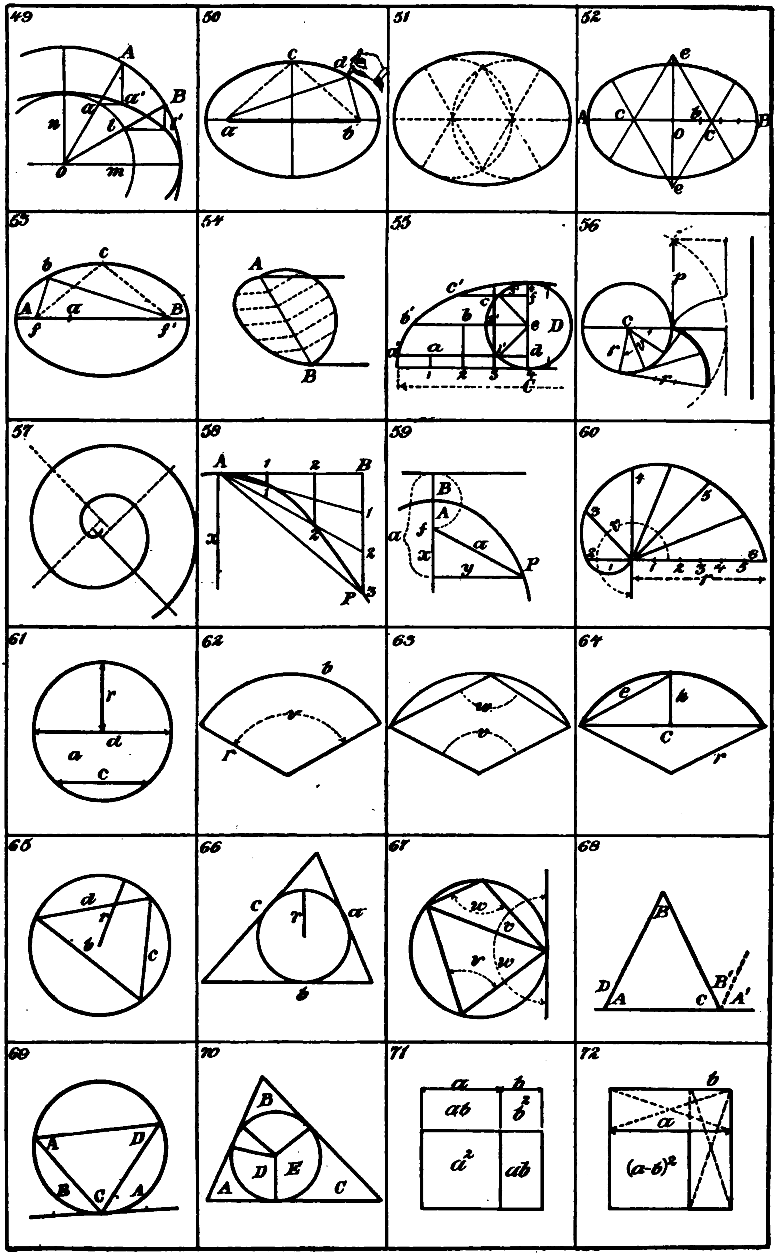
$$d = 2\sqrt{\frac{a}{\pi}} = 1.128\sqrt{a}$$

$$r = \sqrt{\frac{a}{\pi}} = 0.564\sqrt{a}.$$

Area of the Circle.

$$a = \frac{\pi\ d^2}{4} = 0.785d^2$$

$$a = \pi\ r^2 = 3.14r^2.$$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ab
b^2
a^2
ab
$(a-b)^2$

$$a=\frac{p^2}{4\pi}=\frac{p^2}{12.56}.$$

$$a=\frac{pr}{2}=\frac{pd}{4}.$$

$\pi=3.141592653589793238462643383279502884197169399$

$2\pi=6.283185$
$3\pi=9.424778$
$4\pi=12.566370$
$5\pi=15.707963$
$6\pi=18.849556$
$7\pi=21.991148$
$8\pi=25.132741$
$9\pi=28.274334$
$\frac{1}{4}\pi=0.785398$
$\frac{1}{3}\pi=1.047197$
$\frac{1}{2}\pi=1.570796$
$\frac{1}{8}\pi=0.392699$
$\frac{1}{6}\pi=0.523599$
$\frac{1}{12}\pi=0.261799$
$\frac{2}{3}\pi=2.094394$
$\frac{1}{360}\pi=0.008726$
$\frac{1}{\pi}=0.318310$
$\frac{2}{\pi}=0.636619$
$\frac{3}{\pi}=0.954929$
$\frac{4}{\pi}=1.273239$
$\frac{6}{\pi}=1.909859$
$\frac{8}{\pi}=2.546478$
$\frac{12}{\pi}=3.819718$
$\frac{360}{\pi}=114.5915$
$\pi^2=9.869650$
$\sqrt{\pi}=1.772453$
$\sqrt{\frac{1}{\pi}}=0.564189$
$\sqrt{\frac{\pi}{2}}=1.253314$
$\sqrt{\frac{2}{\pi}}=0.797884$
Log. $\pi=0.49714987$

61.
The periphery of a Circle is commonly expressed by the *Greek* letter $\pi=3.14$ when the diameter $d=1$ or the unit. For any other value of the diameter d, we will denote the periphery by the letter p, r=radius, and a= area of the circle. The periphery of a circle is equal to 3 14-100 times its diameter. c=chord.

62.
$$b=\frac{\pi r v}{180}=0.0175rv,$$
$$v=\frac{180b}{\pi r}=57.296\frac{b}{r}.$$

63.
$$w=180-\frac{v}{2},$$
$$v=2(180^\circ-w).$$

64.
$$r=\frac{c^2+4h^2}{8h}=\frac{c^2}{2h},$$
$$c=2\sqrt{2hr-h^2}.$$

65.
$$r=\frac{ac}{2\sqrt{a^2-\left(\frac{a^2+b^2-c^2}{2b}\right)^2}}.$$

66.
$$r=\frac{b\sqrt{a^2-\left(\frac{a^2+b^2-c^2}{2b}\right)^2}}{a+b+c}.$$

67.
$v=v,\quad w=w,$
$w+v=180^\circ,\ w>v.$

68.
$D=B+C,\quad A'+B'+C=180^\circ,$
$B=D-C,\quad A+B+C=180^\circ,$
$A'=A,\quad B'=B.$

69.
$A+B+C=180^\circ,$
$A'=A,\quad B'=B.$

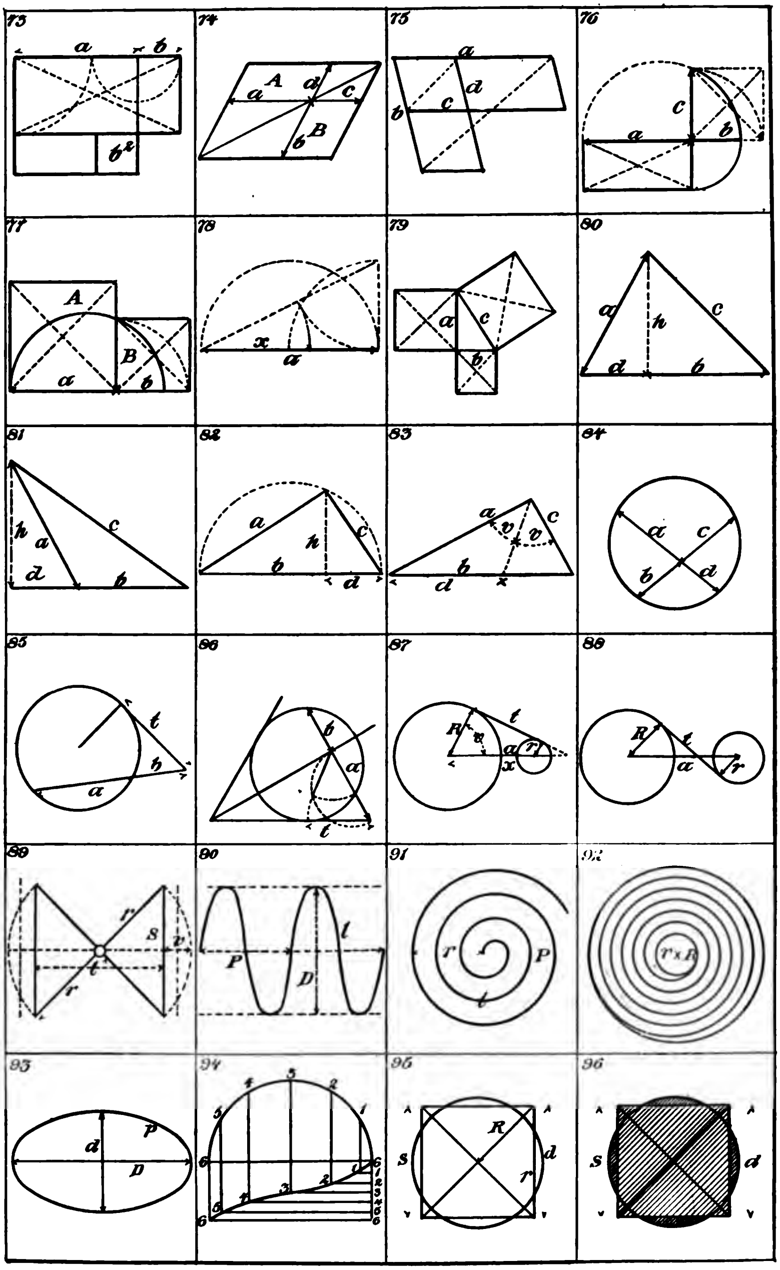
70.
$E+C=A+D=180^\circ,$
$D=B+c,$
$E=A+B.$

71.
$(a+b)^2=a^2+2ab+b^2.$

72.
$(a-b)^2=a^2-2ab+b^2.$

73.
$(a+b)\ (a-b)=a^2-b^2.$

74.
$a:b=c:d,$
$ad=bc,$
$A=B.$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75.
$$a : b = c : d,$$
$$ad = bc.$$

76.
$$a : c = c : b,$$
$$ab = c^2,$$
$$c = \sqrt{ab}.$$

77.
$$A : B = a : b.$$

78.
$$a \cdot x = x : a - x,$$
$$x = \sqrt{a^2 + \left(\frac{a}{2}\right)^2} - \frac{a}{2}$$

79.
$$c^2 = a^2 + b^2,$$
$$a^2 = c^2 - b^2,$$
$$b^2 = c^2 - a^2.$$

80.
$$c^2 = a^2 + b^2 - 2bd,$$
$$h = \sqrt{a^2 - d^2}.$$
$$d = \frac{a^2 + b^2 - c^2}{2b}.$$

81.
$$c^2 = a^2 + b^2 + 2bd,$$
$$h^2 = \sqrt{a^2 - a^2},$$
$$d = \frac{c^2 - a^2 - b^2}{2b}.$$

82.
$$a : b = h : c,$$
$$h = \frac{ac}{b} = \frac{ad}{c},$$
$$d = \frac{c^2}{b} = \frac{ch}{a}.$$

83.
$$a : c = d : (b - d),$$
$$d = \frac{ab}{c + a},$$
$$v = v.$$

84.
$$a : c = b : d,$$
$$ad = bc.$$

85.
$$a : t = t : b,$$
$$t^2 = ab.$$

86.
$$t^2 = (a + b)\ (a - b),$$
$$t = \sqrt{a^2 - b^2}.$$

87.
$$x = \frac{aR}{R - r}, \quad a = \sqrt{t^2 + (R - r)^2},$$
$$t = \sqrt{a^2 - (R - r)^2}, \quad \sin.v = \frac{t}{a}.$$

88.
$$t = \sqrt{a^2 - (R + r)^2},$$
$$a = \sqrt{t^2 + (R + r)^2}.$$

89.
$$V = r - \sqrt{r^2 - \frac{S^2}{4}} \qquad l = 2r - V,$$
$$S = 2\sqrt{r^2 - (r - V)^2}. \quad r = \tfrac{1}{2}(l + V).$$

90.
$$P = \sqrt{\frac{l^2}{n^2} - \pi^2 d^2},$$
$$l = n\sqrt{\pi^2 d^2 + P^2},$$
$$n = \frac{l}{\sqrt{\pi^2 d^2 + P}}.$$

91.
To find the length of a Spiral.
$$l = \pi r n = \frac{\pi r^2}{P}, \quad n = \frac{l}{\pi r} = \frac{r}{P},$$
$$P = \frac{\pi r^2}{l} = \frac{r}{n}. \quad P = Pitch.$$

92.
To find the length of a Spiral.
$$l = \pi n\ (R + r),$$
$$l = \frac{\pi}{P}(R^2 - r^2).$$

93.
Periphery of an Ellipse.
$$p = 2\sqrt{D2 + 1.4674d^2}.$$

94.
To construct a screw *Helix.*

95.
To square a Circumference.
$$R = 0.555355\ d = 1.1107\ r = 0.7071\ S.$$
$$S = 0.785398\ d = 1.57079\ r = 1.4142\ R$$
$$d = 1.27322\ S = 1.79740\ R = 2r.$$

96.
To square a Circleplane.
$$R = 0.626657\ d = 1.253314\ r = 0.7071\ S$$
$$S = 0.886226\ d = 1.77245\ r = 1.4142\ R$$
$$d = 1.12838\ S = 1.5367\ R = 2\ r.$$

CHAPTER II.

MACHINE ELEMENTS

The Machine Elements or Powers are the Lever and the Inclined Plane. Every machine when analyzed is found to be made up of these elements, either singly or in combination; for example, pulleys, gear wheels, etc., are forms of levers, while screws, cams, etc., are forms of inclined planes.

There are four distinct types of levers, as shown in our illustration.

1st. The Common Lever, consisting of a straight inflexible bar movable on a fulcrum. The section of the bar extending from the fulcrum to the point where the power is applied is called the Power Arm, and the section extending from the fulcrum to the point where the weight is applied is called the Weight Arm.

2d. The Angular or Bell Crank Lever. This is distinguished from the Common Lever in having its power arms disposed at an angle to the weight arms.

3d. The Wheel and Axle, or Revolving Lever. A wheel and axle or two concentric wheels take the place of the power and weight arms. The weight is attached to a rope coiled on one of the wheels, and the power is attached to a rope coiled on the other wheel. The relation of this lever to the common lever is indicated by the dotted lines, and it will be evident that this relation remains constant even when the wheels are revolving.

4th. The Pulley. Another type of revolving lever, but differing from the wheel and axle type in that a single wheel is used and the fulcrum is not necessarily always at the center of the wheel.

Each of these types of the simple lever is capable of three different arrangements usually termed "Orders." In the First Order the fulcrum lies between the weight and the power. In the Second Order the weight lies between the fulcrum and the power. In the Third Order the power lies between the fulcrum and the weight. The second order gives the longest power arm relative to the weight arm, and consequently is the most powerful lever of the three. The formulæ for determining the amount of power required to balance a given weight, are given at the bottom of the illustration. In measuring the arms of the angular levers the measurements should not be taken along the length of the arms, but in the horizontal plane as shown, because this measurement represents the true theoretical length of the lever arm. As the lever is moved about the fulcrum, the ratio of the power arm to the weight arm changes as indicated by dotted lines in the first order of angular levers, because the arm that is approaching the horizontal plane is increasing in length, while the other which is moving toward the vertical plane is decreasing in length. The same is true in a modified form of the second and third orders of angular levers.

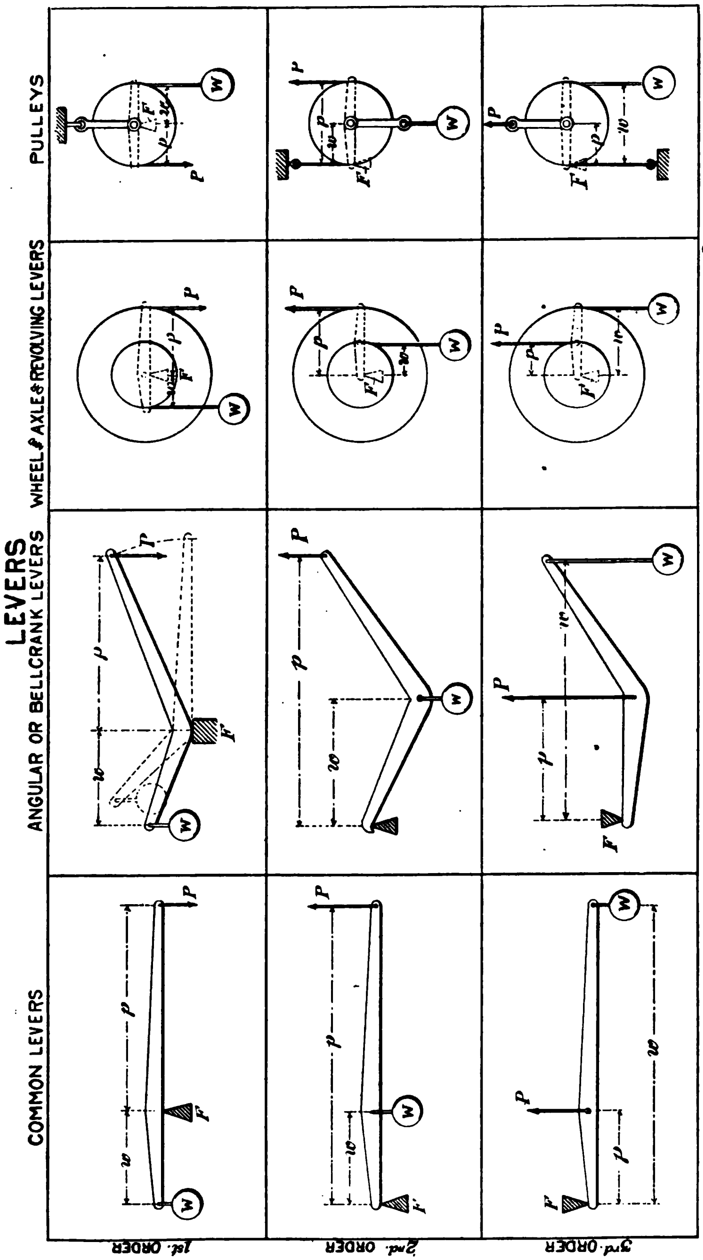
In the case of the pulleys the power and weight arms bear a definite relation to each other. No matter what their size may be, the power arm will always be of the same length as the weight arm in pulleys of the first order, consequently the power must be equal to the weight in order to keep the lever in equilibrium. In pulleys of the second order the power arm will be twice the length of the weight arm, consequently the power must be equal to half of the weight in order to keep the lever in equilibrium; and in pulleys of the third order the power arm will be half the length of the weight arm, consequently the power must equal twice the weight in order to maintain the equilibrium of the lever.

The compound levers consist of two or more simple levers of the same or different orders coupled together, either for the purposes of convenience or to increase the power.

Of the two compound common levers illustrated, Figure 1 shows two common levers of the first order coupled together, and Figure 2 represents a common lever of the first order coupled to a common lever of the second order.

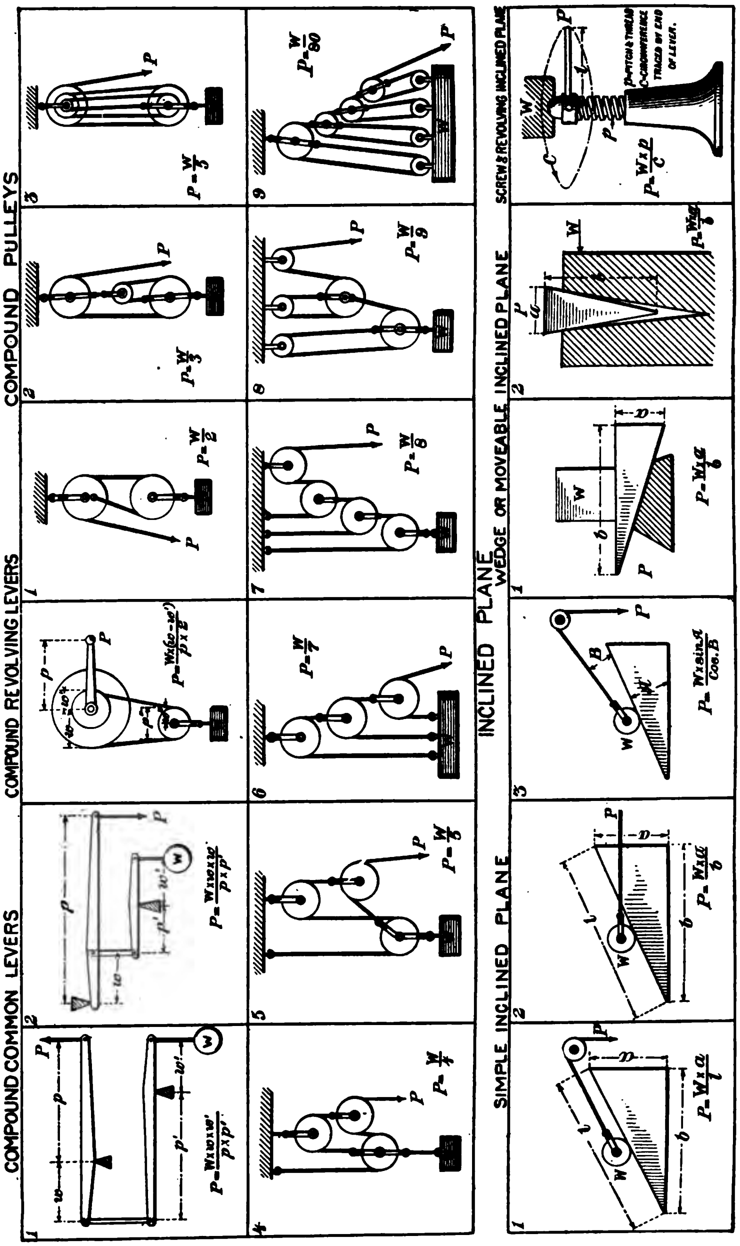
The compound revolving lever illustrated is a combination of a wheel and axle of the second order, operating a pulley of the second order. This compound lever is also called a "Chinese windlass," owing to its early use by the Chinese for lifting heavy weights, such as draw-bridges. etc.

The compound pulleys or tackle shown are various combinations of pulleys of the same or different orders. As in the case of the simple pulleys, the weight and power arms bear a constant relation to each other, and it is therefore possible to give the numerical value of the power in terms of the weight, or *vice versa*, afforded by the different types of tackle, regardless of the size of the individual pulleys they comprise. The following simple formula is applicable to all tackle in which a continuous length of rope is used, as in Figures 1, 2, and 3: *Power equals weight divided by the number of rope parts supporting the weight.* In Figure 3, for instance, there are five such parts, not counting of course the part on which the power is applied. Figures 4 to 9 are all rather complex, owing to the fact that the power is transmitted to the weight through one or more movable pulley blocks connected by separate ropes. Figures 4 and 5 show tackle arrangements called Spanish burtons. A general formula, applicable to any number of pulleys arranged as in Fig. 6, is $P=\frac{W}{2^n-1}$,



P = POWER W = WEIGHT F = FULCRUM p = POWER ARM AND w = WEIGHT ARM $P = \frac{W \times w}{p}$ AND $W = \frac{P \times p}{w}$

MACHINE ELEMENTS I.



MACHINE ELEMENTS II.

in which P represents the power, W the weight, and n the number of ropes used. The general formula for the arrangement shown in Figure 7 is $P=\frac{W}{2^n}$. The general formula for the arrangement shown in Figure 8 is $P=\frac{W}{3^n}$. The general formula for the arrangement shown in Figure 9 is $P=\frac{W}{3^n\ 1}$.

There are three general classes of inclined planes, the simple inclined plane, the wedge or movable inclined plane, and the screw or revolving inclined plane. There are three general types of simple inclined planes, as illustrated. 1st. That in which the power acts in a direction parallel with the inclined face of the inclined plane. 2d. That in which the power acts parallel with the base of the inclined plane. 3d. That in which the power acts at an angle both to the face and to the base of the inclined plane. The formulæ for determining the mechanical advantage secured by the different forms of inclined planes are given in the illustration. In the third type of inclined plane the relation of power to weight changes as the weight is drawn up the plane, owing to the fact that the angle B becomes gradually larger.

There are two types of wedges, the single wedge and the double wedge. The latter is the more common type.

Under revolving inclined planes we have the screw together with the cam (not illustrated here), which are more commonly used in machinery than any other type of inclined plane.

CHAPTER III.

MECHANICAL MOVEMENTS.

TOOTHED GEAR.

1. SPUR GEARS.—The ordinary form of toothed-wheel. The smaller of two intermeshing gear-wheels whether a spur- or bevel-wheel is called a Pinion.

2. GEAR WITH MORTISED TEETH.—This is what is ordinarily known as a Cog-wheel among machinists. The wheel is ordinarily made of iron and the teeth of wood.

3. STEP GEAR.—The face of this gear is divided into sections with the teeth of the different sections arranged in steps; that is, one in advance of the other. Step gear-wheels are useful in heavy machinery, as they give a practically continuous bearing between the intermeshing teeth of the gear-wheels.

4. OBLIQUE TOOTHED GEAR.—The teeth are cut diagonally across the working face of the wheel so as to give the gear-wheel a side thrust. In a double oblique toothed-gear, usually called a V-toothed gear, the thrust in one direction is neutralized by an equal thrust in the opposite direction. As in the stepped-gear it gives a continuous bearing of the teeth.

5. INTERNAL OR ANNULAR GEAR.—The teeth are formed on the inner periphery of a ring. This type of gear is used in heavy machinery, because it offers a greater hold for the teeth of the driving pinion. There is less sliding friction between the teeth than in the usual outside spur-gear and pinion.

6. STAR WHEEL GEARS.—The teeth are so formed as to permit an appreciable separation of the gear-wheels without preventing them from properly meshing one with the other. These gears are used on wringing machines, etc.

7. ELLIPTICAL GEARS.—Due to their elliptical form, while the driving-gear rotates at constant speed, the other gear will be rotated at a variable speed. That is, its motion will first be accelerated and then retarded. They are used in some machines to produce a slow powerful stroke followed by a quick return.

8. ANGULAR GEARS.—These gears have a rectangular form and, as in the elliptical gears, they serve to transform uniform rotary movement into variable rotary movement. However, this movement is more jerky than that produced by elliptical gears. Angular gears are very seldom used.

9. LANTERN GEAR.—The teeth consist of pins which lie parallel with the axis of the gear-wheel, and are secured at their ends in two disks or gear heads. The pins are so spaced as to mesh with the teeth of a spur-gear. The lantern-gear permits limited sliding movement of the spur-gear along its axis. It can be very cheaply made, but is used chiefly for light work, such as clock mechanism, etc.

10. CROWN GEAR.—The teeth project perpendicularly from a side face of the wheel instead of lying in the plane of the wheel. When in mesh with the teeth of a spur-gear or a lantern-gear, it forms a cheap method of transmitting power from one shaft to another lying at right angles thereto. Crown gears are useful for light work, and were common in old clock mechanisms. They used to be known as *Contrate* wheels.

11. BEVEL GEARS.—The ordinary gear for transmitting power from one shaft to another at an angle thereto. When the wheels are of the same size and operate on shafts, lying at an angle of 45 degrees, one with the other, they are called Miter gears.

12. WORM OR SCREW GEAR.—An endless screw engages a spur-gear with spirally disposed teeth. The screw is called a worm, and the spur-gear a worm-wheel. A much diminished but very powerful motion is communicated from the worm to the worm-wheel. It is used in heavy machinery.

13. CURVED WORM GEAR.—The working face of the worm is curved so that a number of teeth will be in mesh with the worm-wheel, thus giving greater strength. It is a difficult matter to cut the thread of this worm correctly owing to its varying pitch. The gear is called the saw-tooth gear when the teeth and thread are V-shaped, as illustrated.

14. SPIRAL OR HELICAL GEARS.—The teeth are spirally disposed on the working faces of the wheels so that they will transmit motion to shafts lying at right angles one with the other.

15. SKEW GEARS.—The gears rotate on shafts which lie in different planes and at an angle with each other. The drawing shows a skew spur-gear meshing with a bevel-gear. The same term would apply to two bevel gears lying in different planes and at angles to each other.

16. RACK AND PINION.—A spur-gear engages a toothed bar. Rectilinear motion is by this mechanism transformed to rotary motion or vice versa. It is quite common in heavy machinery to find a worm meshing with and driving a rack.

17. SPHERICAL OR GLOBOID GEAR. — A spiral thread is cut on a spherical body and meshes with the spiral teeth of the spur pinion. The latter is so mounted that it may be swung to different positions on the spherical gear, thus varying its speed of rotation.

18. GEAR WITH ROLLER TEETH.—The teeth project from the flat face of the wheel, and consist of pins carrying rollers. This construction is used to reduce friction.

19. PIN WHEEL.—The flat face of the gear is studded with pins which are adapted to

mesh with slots formed in the edge of a pinion. The pinion is so mounted that it can be moved toward or from the center of the pin wheel to vary its speed of rotation. When the pinion is moved past the center of the pin wheel its direction of rotation is reversed.

20. SPIRAL HOOP GEAR.—A spiral thread is formed on the flat face of the wheel and this meshes with a worm-wheel. The latter is moved forward one tooth at each complete rotation of the spiral hoop. This gives a powerful drive, though, of course, at a greatly diminished speed.

21. INTERMITTENT GEAR OR GENEVA STOP.—The driving-wheel is provided with a single tooth adapted to engage one of a series of notches in the other wheel. At each complete rotation of the driving-wheel the other wheel is moved forward one notch but no more, due to the concave space between the notches which fits closely against the circumference of the other wheel. In the Geneva stop one of these spaces is formed with a convex outline, as illustrated. When this space is reached both wheels are prevented from further rotation forward. The Geneva stop is used on watches to prevent winding up the main spring too tightly.

22. INTERMITTENT BEVEL GEAR OR MUTILATED GEAR.—The teeth are formed only at intervals on the face of the gears. The space between the teeth in the driving-gear is convex, and that between the teeth in the other gear is concave, so that when the teeth are not in mesh with each other these convex and concave portions fit into each other and prevent the driven gear from moving forward under its own momentum.

23. VARIABLE GEARS.—The gear wheels are made up of gear sectors of different radial length, which produce suddenly varying motions of the driven gear due to the varying leverage between the wheels. The segments are arranged on different planes so as not to interfere one with the other.

24. SCROLL GEARS.—The gears have a scroll form which produces a gradually increasing or decreasing speed during each rotation. These gears are also called cam gears.

25. ELLIPTICAL BEVEL GEARS.—They produce variable motion of a shaft lying at right angles to the driving shaft. This gear is used on bicycles to give increased power on the downstroke of the pedal and a quick movement on the return.

26. VARIABLE PIN WHEEL.—A cone is provided with pins arranged spirally thereon, and these mesh with teeth formed on the other cone. When one cone is rotated at a constant speed the other moves with a gradually increasing or decreasing speed during each rotation.

27. CAM-TOOTHED PINION.—The pinion consists of two oppositely disposed heart-shaped teeth, mounted side by side, on a shaft. The gear-wheel with which they mesh has teeth alternately arranged on opposite side faces. Due to the form of the pinion teeth, the gear-wheel is locked after being moved forward by one tooth until the other tooth comes into mesh with a tooth on the other face of the wheel.

28. BEVEL SCROLL GEAR.—The gear-wheel consists of a bevel spiral scroll which meshes with a bevel pinion. As the spiral scroll rotates it causes the pinion to slide forward on its shaft, and thus varies its speed.

FRICTION GEAR.

29. FLAT-FACED FRICTION GEAR.—A common type of friction gear. The wheels are usually faced with rubber or leather to increase the frictional hold between the wheels. One of the wheels is journaled in bearings which can be adjusted toward the other wheel so as to increase the frictional engagement.

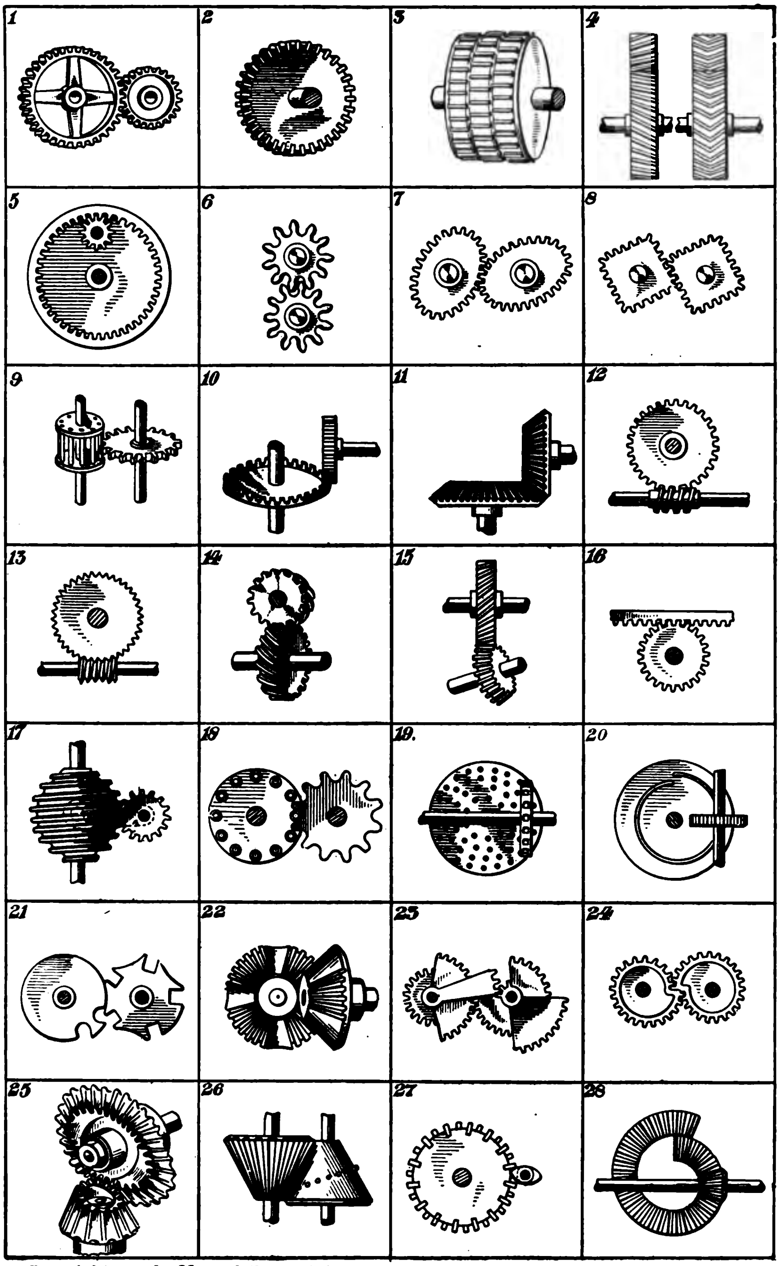
30. GROOVED FRICTION GEAR.—The faces of the wheels are grooved so as to increase the bearing surface. The best results are obtained by pressing the wheels but slightly into engagement with each other, as this produces little loss of power by friction.

31. ADJUSTABLE FRICTION PINION.—The pinion is formed of a disk of rubber or other flexible material held between two washers. When these washers are tightened together they press out the rubber between them, crowding it into closer contact with the V-groove of the gear with which it engages.

32. BEVELED FRICTION GEAR.—Two cone frustums are used to convey motion from one shaft to another at right angles thereto.

33. FRICTION DRUMS.—The drums have concave faces which permit them to transmit motion one to the other while lying at an acute angle with each other.

34 to 40. VARIABLE SPEED FRICTION GEAR.—34, a pinion, engages the flat face of the friction disk. Variable motion is produced by moving the pinion across the face of the disk. When the center of the disk is reached no motion is transmitted. Beyond the center the direction of motion transmitted is reversed. 35. Motion is transmitted from one friction disk to another lying parallel, but not in alignment therewith, through an intermediary pinion. This pinion can be moved vertically to engage different points on the friction disks, and thus produce any desired variation in the speed transmitted. 36. Two convex friction disks are so arranged that one may be swung through an angle bringing different points on its surface into contact with the face of the other disk. In this manner the speed of the motion transmitted is varied. This gear is used on sewing-machines. 37. Two parallel friction disks are each provided with an annular concavity. Motion is transmitted from one disk to the other by a friction pinion mounted between the disks, and so arranged that it can be rotated to engage different points on the surfaces of the concavities, thereby varying the speed transmitted. 38. A cone with concave face is engaged by a pinion which may be swung about a center to engage different points on the face of the cone. 39. Two cones with concave faces are mounted on shafts running at right angles to each other. Motion is transmitted from one cone to the other through a friction pinion mounted to swivel so as to engage different points on the faces of the cones. 40. Two friction cones are mounted on parallel shafts, and between them runs a friction pinion having two faces, one engaging the upper cone and the other engaging the lower cone. This provides a broad bearing surface. The pinion may be moved to different positions along the faces of the cones, and thereby produce changes in the speed.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CHAIN GEAR.

41. Sprocket Wheel.—The wheel is provided with teeth adapted to fit in between the links of a chain. The chain may be of the ordinary oval welded link type or of the flat riveted type used on bicycles.

42. Link-belt Wheel.—The chain is made up of square links which are engaged by ratchet-shaped teeth on the chain wheel.

43. Pocket Wheel.—The wheel is formed with pockets into which the links of the chain are adapted to fit.

44. Side-toothed Wheel.—The wheel is formed with two sets of teeth between which the chain travels. The teeth bear against the ends of the outer links of the chain.

45. Side and Center Toothed Chain Wheel.—This wheel is similar to that shown in Fig. 44, but has in addition a row of teeth along the center which bear against the center link of the chain.

46. Toothed-link Chain and Wheel.—The links are formed with projecting teeth which fit into notches on the rim of the chain wheel.

47. "Silent" Chain and Wheel.—This is a special type of chain in which each link is formed with a tooth at each end. The teeth of adjacent links coact to completely fill the spaces between the teeth of the chain wheel. The construction is such as to produce a noiseless operation of the chain gear even at high speeds.

48. Detachable Toothed-link Belt and Wheel.—Each link is formed with a tooth, which meshes with the teeth of the chain wheel. The construction of each link is such that it may be readily slipped into or out of engagement with the next link of the chain.

ROPE GEAR.

49. V-Pulley.—The ordinary type of pulley for round ropes or cables. Owing to the V-shaped construction of the pulley groove, the rope wedges tightly into engagement with the pulley.

50. Pulley with Flexible Filling.—In order to secure frictional engagement of the cable with this pulley, the pulley groove is provided with rubber, leather, wooden, or other filling.

51. Pulley with Ribbed Groove.—In this construction of pulley the required grip is produced by forming ribs in the bottom of a pulley groove.

52. Pulley with Gripping Lugs.—The flanges of this pulley are formed with lugs which kink the rope or cable as shown, thus producing the required grip.

53. Rope Sprocket-wheel.—An old form of rope gear used in hoists and the like.

54 and 55. Gripping Pulleys.—Gripping arms are provided which grip the cable at the point where the cable presses into the pulley. In 54 the gripping arms are wedged inward by the side walls of the pulley groove when pressed downward by the cable. These arms are normally h ld up by coil springs. In 55 the cable is gripped by the toggle movement of hinged clips placed at intervals along the periphery of the pulley.

56. Cable Sprocket-wheel.—The cable is provided with clamps which enter sockets formed in the cable wheel. This is a form of cable gear commonly used at present in elevating and conveying machinery.

CLUTCHES.

57. Common Jaw Clutch.—One member of the clutch is mounted to slide on a feathered shaft, and the other member which is connected with the machinery is normally stationary on this shaft. When the slidable member is moved forward the teeth on its forward edge intermesh with the teeth of the other member, setting the machinery in motion. The slidable member is moved forward by means of a forked lever which is hinged to a split collar mounted loosely between flanges on the clutch member.

58. Claw Clutch.—The slidable member of the clutch consists of a body portion with two claw arms which, when moved forward, are adapted to engage opposite sides of a bar on the other member of the clutch.

59. Lever Clutch.—The slidable member is provided with a lever loosely hinged to its forward end. The other member of the clutch consists of a disk formed with ratchet teeth on its face. These are engaged by the hinged arm when the shaft rotates in one direction, but the arm moves freely over them when rotated in the opposite direction.

60. Knee and Rose Clutch.—A crank arm is attached to the slidable member of the clutch, and engages a pin on an arm loosely hinged to the opposite member of the clutch.

61. Ratchet Clutch.—The clutch members are formed with ratchet teeth, so that when the motion of the driving shaft is reversed, the members will be disengaged.

62. Pin Clutch.—The slidable member is provided with radial arms formed with pins at their outer ends which are adapted to enter sockets formed along the periphery of a disk on the opposite member of the clutch.

63. Friction Disk Clutch.—The two clutch members are each formed with disks preferably faced with rubber or leather, so that when pressed together their frictional engagement will cause a transmission of motion from the rotating disk to the other.

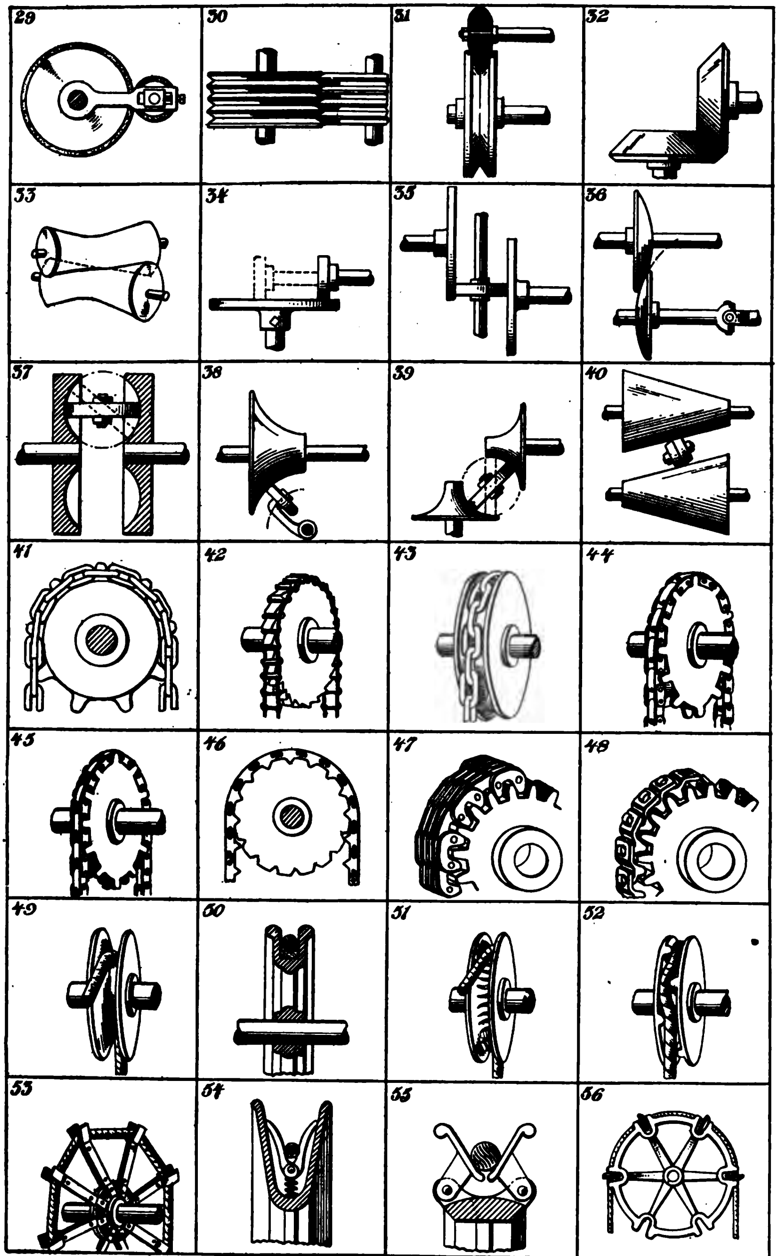
64. Friction Groove Clutch.—One of the clutch members is formed with a groove in its face to receive the lip of the other member which is cup-shaped. Both the lip and the side walls of the groove are slightly tapered to insure a close fit, even after the parts have been partly worn away by friction.

65. Stud Clutch.—Engagement between the two members of the clutch is effected by means of a stud on each disk adapted to enter a notch formed in the periphery of the opposing disk.

66. Friction Band Clutch.—One member of the clutch consists of a pulley provided with a steel band which encircles and fits tightly on its periphery. The other member of the clutch consists of a lever provided with pins at its outer ends, which are adapted to engage the steel band. Since this band is not fastened to the pulley, any shock due to suddenly throwing the clutch members into engagement will be taken up by the steel band slipping on the face of the pulley.

67. Friction Cone Clutch.—The clutch is made up of two cones, one adapted to fit into the other. The frictional engagement causes one to drive the other.

68. Self-releasing Clutch.—The clutch disks are provided with inclined teeth, so that in case the resistance to the driven shaft in-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creases beyond a certain degree, the clutch members will automatically move apart.

69. Cam Clutch.—One of the members is cup shaped, and within this the other member operates. The latter comprises a number of cam-shaped arms hinged to a body portion, and so arranged that when moved in one direction they will bind against the inner wall of the drum, but when moved in the opposite direction they will be automatically disengaged therefrom.

70. V-grooved Clutch.—The clutch disks are formed with annular V-grooves adapted to fit into each other, and thus increase the friction surface of the clutch members.

71. Expansion Clutch. — The slidable member is provided with a number of movable ring segments connected by radial arms to the main body of the clutch and adapted to bear against the inner surface of the drum or cup which constitutes the other member of the clutch. When the slidable member is moved forward, by reason of the toggle action of the radial arms, the segments are brought into frictional engagement with the other member of the clutch.

72. Coil-grip Clutch. — The movable member of the clutch is formed with a number of coils of steel in which there is a central conical opening. This is moved over the cone which constitutes the opposite member of the clutch, producing the required frictional engagement of the two members.

ANGLE SHAFT COUPLINGS AND UNIVERSAL JOINTS.

73. Crank and Hinged-pin Coupling.—A coupling for shafts which lie at an angle to each other. One shaft carries a hinged pin which fits into an opening in the outer end of a crank arm carried by the other shaft.

74. Double-sleeve Angle Coupling.—Each shaft carries a crank arm provided with a pin at its outer end, which lies parallel with its respective shaft. The two pins enter a coupling device consisting of two sleeves integrally formed, but lying at an angle with each other which corresponds to the angle formed by the shafts. Through this double-sleeve coupling, motion is transmitted from one shaft to the other, the pins sliding back and forth in the sleeve openings.

75. Cross-bar Angle Coupling.—This is used for coupling two parallel but offset shafts. Each shaft carries a yoke piece provided with sleeves at its outer ends. The coupling member is a cross-shaped piece, its arms fitting into the sleeves of the yoke pieces, and permitting the necessary lateral play as the shaft rotates. This form of coupling is also applicable to shafts which lie at an angle with each other.

76. Pin and Slot Coupling.—A crank pin carried by one shaft engages a slot in a crank arm carried by the other shaft. The motion transmitted is variable, due to the fact that the leverage varies as the pin moves up and down in the slot.

77. Ring-Gimbal Universal Joint.—The ends of the shafts are provided with yoke members whose arms are pivoted to a ring-gimbal, the pivot pins of the two yoke pieces lying at right angles to each other. This coupling will communicate motion at any angle under 45 degs. For angles of over 45 degs. a double-link universal joint is used.

78. Double-link Universal Joint.—A link forked at each end is hinged to two rings, which are mounted in the yoke pieces on the ends of the shafts. In place of rings cross pieces such as shown in the illustration are often used.

79. Hooke's Angular Coupling.—The shafts are connected by two double links which are arranged in the form of a parallelogram. Intermediate of the shafts the links are connected with ball-and-socket joints.

80. Ball-and-socket Universal Joint.—Socket pieces are secured to the ends of the shafts, and these are provided with metal bands which encircle the ball that constitutes the coupling member. The bands enter grooves in the ball which lie at right angles to each other.

81. "Almond" Angular Coupling.—A side view of the coupling is shown at 1 and a plan view at 2. Between the shafts to be coupled is a fixed stud on which a bell crank is mounted to turn. The bell crank is permitted to slide axially on the stud. The bell crank is connected at the ends by ball-and-socket joints with links attached to the ends of the shafts. Now, as the power shaft rotates, rotary motion will be communicated to the other shaft through the bell crank, which will rock and also slide axially on the stud.

82. Flexible Shaft.—Two shafts are connected by a flexible shaft consisting of a coil spring, or a metal tube in which a helical saw-slot has been cut. This flexible shaft will permit transmission of motion through a wide angular range.

83. Linked Flexible Shaft.—The flexible shaft is made up of a series of links coupled together with universal joints. A coil spring fits loosely over the links and prevents them from kinking. This spring in turn is covered with a flexible tube. The shaft will transmit motion about almost any curve or angle. It can be used for heavy work.

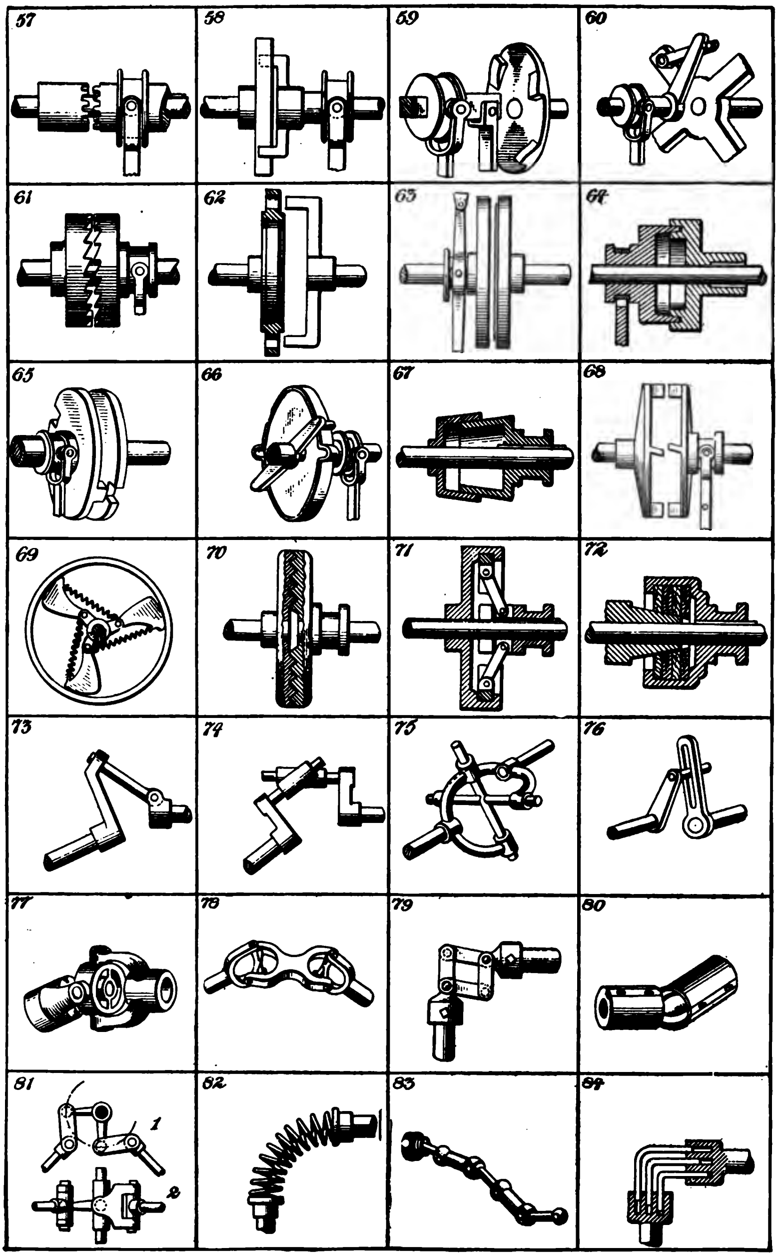
84. Right-angle Coupling.—The ends of the shafts are formed with heads in which are drilled a number of sockets. A series of rods, each bent to form a right angle, enter these slots and form the coupling links between the shafts. As the shafts rotate these rods slide in and out of their sockets.

RATCHET MOVEMENTS.

85. The teeth of a ratchet wheel are engaged by a pawl hinged to a rocking arm. The ratchet wheel is rotated only on the forward stroke of the arm.

86. A rocking lever carries two pawls, one on each side of its fulcrum. The wheel is rotated both by the downward and the return stroke of the lever; for while one pawl is rotating the wheel, the other swings to position to take a new hold on the ratchet wheel. The rotation of the ratchet wheel is thus kept nearly constant.

87. A ratchet crown-wheel or rag-wheel is engaged by pawls depending from two arms loosely pivoted on the axle of the ratchet-wheel. These two arms are connected by links to a common power arm. Rectilinear reciprocating movement of the latter in the line of the arrow produces an almost constant rotation of the ratchet-wheel.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88. The action of this ratchet mechanism is very similar to that shown in Fig. 86, except that the pawls are hooked and ratchet-wheel is rotated by an alternating pulling rather than pushing action of the pawls.

89. This is a modification of the principle pictured in Fig. 88, and shows a rocking lever with two pawls hinged thereon engaging a ratchet rack.

90. Another modification of the principle shown in 88. The rocking lever is mounted on a fixed stud and is provided at the center with a pin which enters a slot in a ratchet bar. The latter is formed with ratchet teeth on its opposite edges which are engaged by hooked pawls pivoted on the rocking lever. These pawls are crossed, as shown, so that they will be kept by gravity in constant engagement with the ratchet teeth. Now, when the lever is rocked the pawls will alternately act to lift the ratchet bar.

91. A common construction used for rotating a ratchet-wheel against a spring resistance. A dog mounted on a fixed pivot drops by gravity or by spring pressure against the ratchet teeth and holds the wheel from turning while the pawl is being swung back for a fresh hold on the ratchet-wheel.

92. This shows the method of rotating an ordinary spur gear-wheel by means of a pawl. The pawl is provided with a tooth at its outer end which fits between the teeth of the gear. The pawl is hinged to the lower arm of the bell-crank lever mounted on the gear shaft. The operating lever also mounted on this shaft is permitted a certain amount of play between two pins on the shorter arm of the bell crank-lever. A rod connects the operating lever with the pawl. When the lever is raised it first lifts the pawl out of engagement with the gear, then, coming in contact with the upper pin on the bell crank-lever, it moves the pawl and bell crank back to the desired position. On lowering the operating lever the pawl is first brought into engagement with the gear and then the lower pin on the bell crank is encountered, and the gear is caused to rotate. This arrangement prevents wearing away of the teeth—a common defect in the ordinary type of ratchet mechanism.

93. The pawl is kept in contact with the ratchet-wheel by the weight of the lever on which it is formed. By pulling the rope attached to the end of the lever the pawl will be drawn out of engagement with the ratchet-wheel, and the latter will be turned by friction of the rope on the wheel hub.

94. A reversible spur-gear ratchet mechanism. Mounted on the shaft which carries the spur-gear is a bell crank-lever. This at one end carries a double-toothed pawl, one of which teeth meshes with the teeth of the gear. The pawl is so shaped that it will withdraw the tooth from engagement with the gear teeth on the return stroke of the lever. When it is desired to reverse the direction of rotation, the pawl is moved over to the position shown in dotted lines, bringing its other tooth into engagement with the gear teeth.

95. The ratchet-wheel is intermittently rotated by the oscillation of a lever which carries a spring-pressed pawl. On the upward stroke the ratchet is turned by the pawl which is backed by a shoulder on the lever. On the return stroke a dog holds the ratchet-wheel from turning while the pawl snaps past.

96. Ratchet teeth are formed on a ball which rests in a socket formed at the end of a lever. A spring pawl on this lever engages the ratchet teeth at any position of the lever. This construction is useful for ratchet braces which have to be operated in inconvenient places.

97. A device for converting rotary motion into vibratory motion. A spring-pressed pin engages the teeth of a revolving crown-wheel ratchet, and is thereby caused to vibrate.

98. A device for converting reciprocating motion into intermittent rotary motion. The crown-wheel ratchet is intermittently rotated by a reciprocating lever carrying a pawl which engages the ratchet teeth.

99. Internal ratchet used on ratchet braces, etc. The drill spindle carries a number of spring-pressed pawls which bear against the internal ratchet teeth formed in the handle of the brace.

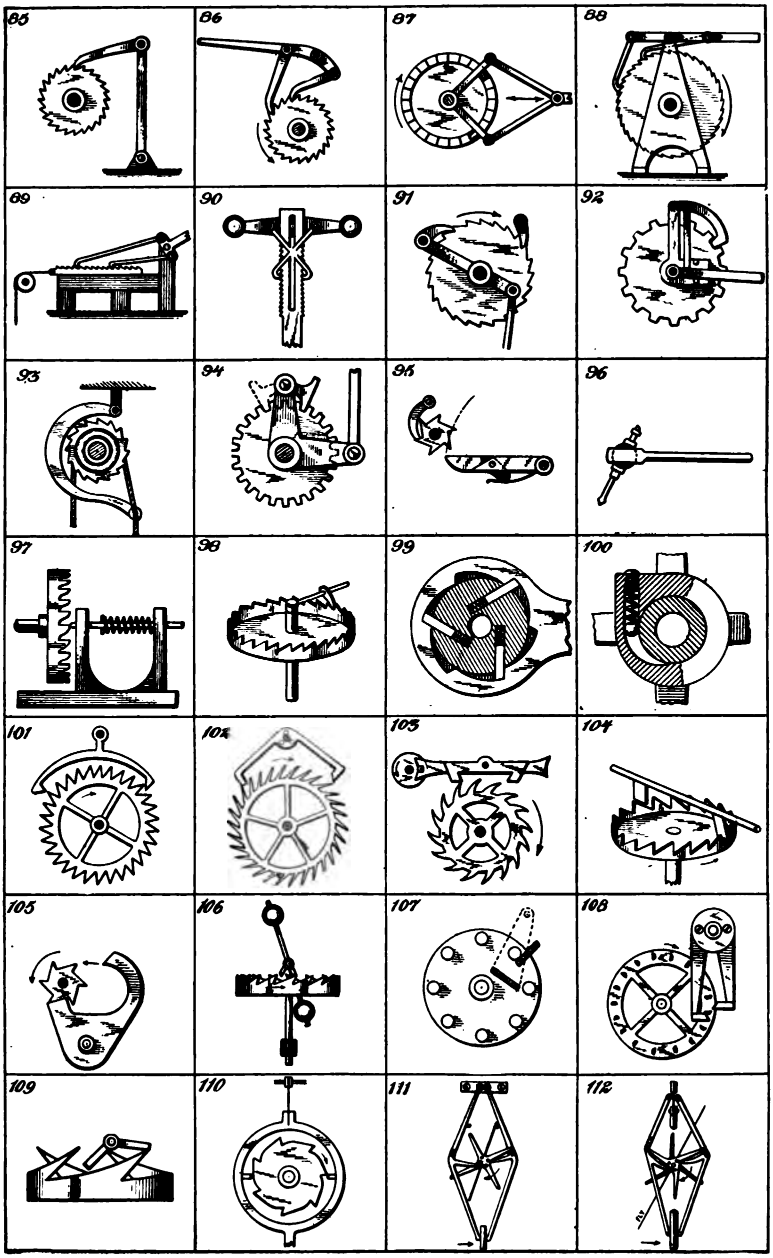
100. Ball ratchet device for lawn mowers, etc. In the hub of a wheel is a groove in which a ball is carried. A spring presses this ball down against a shaft on which the wheel turns. When the wheel rotates forward, the ball wedges in between the shaft and the groove, causing the shaft to turn with the wheel. When the direction of rotation is reversed, the ball is forced up against the spring, releasing the shaft.

ESCAPEMENTS.

101. Recoil Escapement.—This is a common form of escapement used on clocks. The pallets carried by the pendulum are so mounted that when a tooth of the escape wheel, which is driven by the clock-train, is just escaping from one of the pallets, another tooth falls on the other pallet near its point. As the pendulum swings on, however, the taper face of the pallet bearing against the tooth causes the escape wheel to turn slightly backward. As the pendulum swings back, it receives an impulse from the escape wheel which is greater by reason of this recoil. The principal value of the recoil, however, is to overcome any unevenness in the pressure exerted by the train, which might otherwise stop the clock.

102. Dead-beat Escapement.—A form of escapement used on the best clocks. The teeth of the escape wheel fall "dead" upon the pallets, that is, the pallets are so cut that as the pendulum continues to swing they slide on the teeth without turning the escape wheel backward. The ends of the pallets are formed with inclined faces, termed "impulse faces," against which the teeth of the escape wheel bear when giving impulse to the pendulum. The value of this escapement lies in the fact that it gives a very even beat of the pendulum even when there is a slight variation in the force exerted by the clock train.

103. Lever Escapement.—This is an escapement used on watches. The anchor on which the pallets are carried is secured to a lever, formed with a notch in one end. This notch is engaged by a pin on the arbor of the balance wheel. The teeth of the escape wheel alternately bear against the inclined faces of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the pallets and oscillate the lever, which turns the balance wheel alternately in opposite directions.

104. Verge Escapement.—A form of escapement used in old-fashioned watches. The escape wheel is a crown wheel, and its teeth, on opposite sides, are engaged by two pallets, carried on the shaft of the balance wheel. The escapement teeth, acting alternately on the pallets, lift and clear them, thus rocking the shaft and balance wheel, which governs the frequency of the escape.

105. Star Wheel Escapement.—The escape has but few teeth and is, therefore, called a star wheel. The pallets act on teeth that lie diametrically opposite each other. This escapement has a dead-beat action.

106. Crown Tooth Escapement.—An old form of recoil escapement, in which a crown escape wheel is used. The pallets are mounted to engage opposite sides of the wheel. This type is objectionable, owing to the fact that the pendulum must oscillate through a very wide angle in order to permit the teeth to escape from the pallets, which requires a greater pressure in the clock-train and heavier parts and produces greater friction on the pallets.

107. Lantern Wheel Escapement.—An old-fashioned type of escapement, in which the escape wheel is a lantern wheel, and the pallets are two plates set at angles on a rocking arm.

108. Pin-wheel Escapement.—A dead-beat escapement used in many of the best turret clocks. The escape wheel is formed with pins which drop on to the "dead" faces of the pallets, but give impulses to the pendulum by sliding off the inclined "impulse" faces of the pallets. It is found best in practice to cut the "dead" faces so as to give a very slight recoil.

109. Old-fashioned Crown Wheel Escapement.—This, in appearance, is quite similar to the escapement shown in Figure 106, but is different in action. The inclined faces of the teeth, which are very long, act to lift the pallets.

110. Ring Escapement.—A form of "dead-beat" escapement. The pallets are formed on the inside of the ring, within which the escape wheel turns.

111 and 112. Gravity Escapements.—A type of escapement in which the impulse from the escape wheel is not given directly to the pendulum, but through the medium of two weights, usually the arms on which the pallets are carried and which are alternately lifted by the escape wheel and dropped against the pendulum. Figure 111 shows the four-legged gravity escapement used on turret clocks. The escape wheel is formed with four legs or teeth, and carries eight pins, four on one face of the hub and four on the other. The pallet arms are pivoted as near as possible to the point from which the pendulum swings. The pallets which are formed on these arms are arranged to lie one on one side and the other on the other side of the escape wheel. The pallet arms are each provided with a stop piece against which the teeth of the escapement will alternately rest. In the illustration, a tooth of the escape wheel is resting against the stop on the right-hand arm. As the pendulum swings toward the right, the tooth will escape from the stop, permitting the wheel to rotate until it encounters the stop on the left-hand arm, at the same time a pin on the wheel engages the end of the pallet at the left, and lifts the pallet arm. In the meantime the right-hand pallet arm swings with the pendulum to the end of its stroke, but falls with it on the return stroke until stopped by a pin on the escape wheel. It will be evident that the angle through which the pallet arm falls with the pendulum is greater than that through which it is lifted by the pendulum, and it is this difference in travel which gives impulse to the pendulum. Figure 112 shows a double, three-legged escapement which is used for very large clocks. Two three-legged escape wheels are used with three lifting pins held between them like the pins of a lantern wheel. The pallets operate between the wheels. A stop piece is placed on one of the pallet arms for the forward wheel, and the other arm carries a stop for the rear wheel. The teeth of one wheel are set 60 degrees in advance of the other. The action is similar to that of the four-legged escapement. A tooth of the forward wheel is shown resting on its stop. When this is released by the swinging pendulum, the wheels rotate, lifting the left-hand pallet until a tooth of the rear wheel engages its stop. The right pallet arm, however, continues to be lifted by the pendulum, and then falls with it, giving it impulse until arrested by a lifting pin, only to be lifted again when the pendulum releases the rear wheel from its stop.

GEARING.

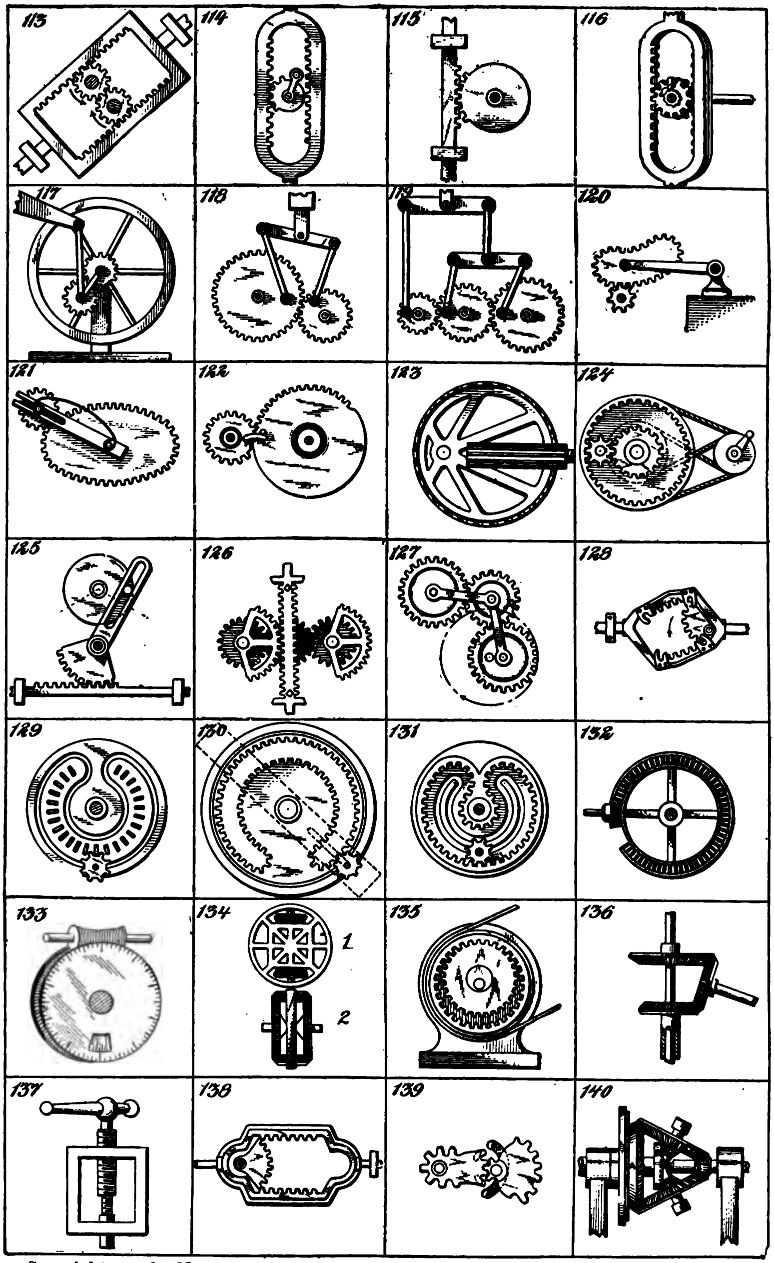
113. A means for changing rectilinear reciprocating motion to rotary reciprocating motion and vice versa. Two intermeshing pinions engage internal racks formed on opposite sides of a frame.

114. Means for changing rotary motion to rectilinear reciprocating motion. A rotating sector or pinion formed with teeth on only a portion of its periphery imparts reciprocating motion to a rack frame by first engaging the teeth at one side of the rack, and then the teeth on the other side of the rack. See Figure 115 for gravity return.

115. Another method of converting rotary motion into rectilinear reciprocating motion. A rotating sector engages the teeth of a rack during a part of its rotation and thereby lifts the rack, but as soon as the rack clears the sector teeth, it drops by gravity, ready to be lifted up when it again encounters the teeth of the sector. See Figure 114 for power return.

116 A movement designed as a substitute for a crank. The rack frame is formed with internal racks on opposite sides, but these racks lie in different planes. Two separate pinions are employed which mesh respectively with these racks. The pinions are mounted loosely on a shaft, but carry pawls which engage with ratchet wheels secured to the shaft. On the forward stroke of the rack frame the pinions will both be rotated but in opposite directions. However, due to their ratchet and pawl connection with the shaft, only one pinion turns the shaft. On the return stroke the rotation of the pinions will be reversed but the shaft will continue to rotate in the same direction, driven this time by the other pinion of the pair.

117. Sun and Planet gearing. A gear wheel, called the "sun" wheel, rotating on a fixed center, is engaged by a gear wheel called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the planet wheel, which revolves about the sun wheel. This construction was used by James Watt in one of his steam engines as a substitute for a crank. The planet wheel was rigidly secured to the connecting rod and connected by an arm to the center of the sun wheel. At each complete revolution of the planet wheel about the sun wheel, the latter was caused to rotate twice.

118 and 119. Means for converting rotary motion into irregular reciprocal motion. In 118 two intermeshing spur gears are provided with crank arms connected by a working beam. If the gears are of equal size the motion transmitted to the rod secured to the working beam will be uniform. If, however, the gears are of different sizes, the motion of this rod will vary greatly. In 119 a still more complex movement is produced, since there are three intermeshing gear wheels of unequal sizes and two connected working beams.

120. Irregular oscillatory motion is given to a hinged arm by pivoting at its outer end a cam-shaped gear wheel which is rotated by a continuously driven pinion. Any desired motion of the arm may be produced by varying the shape of the cam gear.

121. Means for converting uniform rotary motion into variable rotary motion. An elliptical gear rotates at uniform speed and drives a spur pinion. The latter is secured to a shaft which slides between the arms of two forked levers. A spring keeps the pinion in mesh with the elliptical gear.

122. Means for converting constant rotary motion into intermittent rotary motion. The driving wheel is formed with teeth through a portion of its periphery equal to the toothed periphery of the pinion. The latter is cut away at one place to fit the plane portion of the driving wheel. This prevents the pinion from rotating until a pin on the wheel strikes a projecting arm on the pinion and guides the teeth of the gears into mesh with each other.

123. Means for converting uniform rotary motion into variable rotary motion. A crown wheel eccentrically mounted is driven by a pinion rotating at uniform speed. The point of engagement of the crown wheel with the pinion varies radially, causing the wheel to rotate at a variable speed.

124. The mechanism is so arranged as to impart planetary movement to a pinion. An internal gear wheel formed with a pulley groove in its periphery is mounted to rotate on a sleeve which carries a spur gear at one end and a pulley at the other. The gear wheels are belted to a driving pulley in such manner as to rotate in opposite directions. A spur pinion which fits in between the teeth of the two gears is rotated thereby on its own axis and revolves about the center of the two gears at a speed which is the differential of the speeds of the two gears.

125. The construction here shown is adapted to produce a slow forward movement of a rack with a quick return. The rack is mounted to slide longitudinally and is driven by a toothed sector. The latter is provided with a slotted arm which is engaged by a pin on a rotating disk. The forward movement will take place while the pin is passing through the larger arc subtended by the two dotted radial lines shown, and there turn while the pin is passing through the smaller arc.

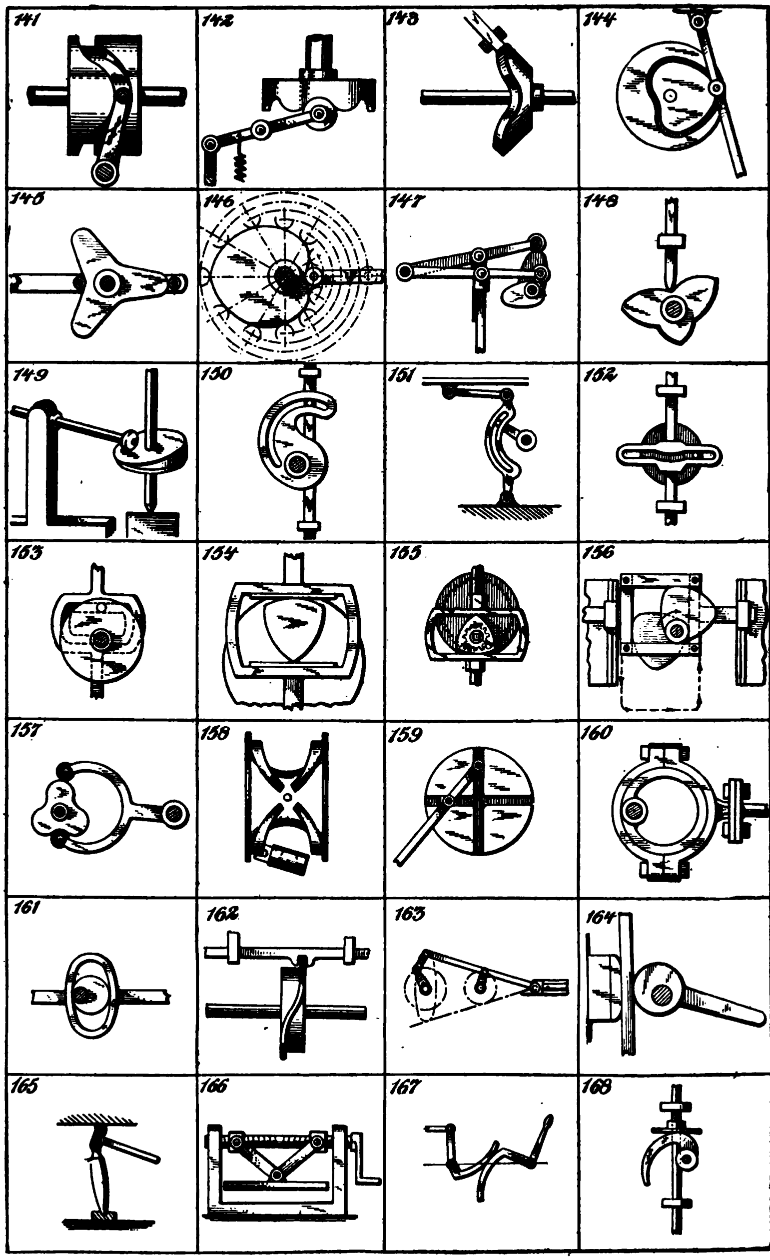
126. A means for converting reciprocating motion into continuous rotary motion. A double-faced reciprocating rack engages first one and then the other of a pair of toothed sectors. The sectors are mounted on a pair of shafts, disposed on opposite sides of the rack. The shafts carry pinions which engage opposite sides of the central gear wheel. The rotary motion alternately imparted to the sectors, is conveyed through these pinions to the gear wheel, each pinion alternately acting to drive the wheel when its respective sector is in mesh with the rack, and then to be driven by the gear wheel until its sector is brought again in mesh with the rack. Thus a continuous rotary motion is produced.

127 Mechanism for converting uniform rotary motion into irregular rotary motion. Mounted eccentrically on the driving shaft is a gear wheel which transmits motion to another gear wheel through an intermediate pinion. Pivoted to the centers of the two gear wheels are two links whose outer ends are connected by a hinge pin on which the pinion rotates. These links serve to hold the pinion constantly in mesh with the gears, no matter what the position of the eccentric is.

128. Means for converting uniform rotary motion into variable reciprocating motion. A rack frame mounted to slide longitudinally is driven by an eccentric-toothed sector. The racks are placed at an angle with the line of movement and are provided with jaws at each end adapted to mesh with pins projecting above the face of the sector. As the sector rotates it transmits a gradually accelerated longitudinal movement to the rack frame until the outer pin engages the jaw at the end of the rack. The rack frame is then driven by this pin until the opposite rack is engaged by the sector teeth.

129 to 132. MANGLE GEARS.—So-called because of their use on mangle machines. 129. The larger wheel is formed with a cam groove which guides the pinion. The shaft of the latter is ordinarily provided with a universal joint, which permits it to move vertically and thus keep in mesh with the crown teeth formed on the large wheel. The pinion meshes first with the outer and then with the inner ends of the teeth on the larger gear, driving the latter first in one direction and then in the other. 130 shows another form of the same movement. The pinion moves radially in the slot shown in dotted lines, and engages first the outer and then the inner line of teeth on the mangle wheel, causing the latter to rotate first in one direction and then in the other. 131. The mangle wheel is formed with an internal gear, and the pinion is guided by a cam groove. This construction and that shown in Figure 130 produce uniform motion through an almost complete rotation, and this is followed by a quick return due to the smaller radius of the inner circle of teeth. 132. In this construction, as in that of Figure 129, the same speed is maintained in both directions of rotation. The mangle wheel in Figure 132 is formed with teeth on both faces; the pinion first engages the teeth on one face of the wheel, and then passing through the opening engages the teeth on the opposite face, thus reversing the direction of rotation.

133 to 137. DIFFERENTIAL GEAR.—133. Two worm wheels, one of which has more teeth than the other, engage a single worm. Suppose that one wheel has 100 teeth and the other has 101; then at every complete rota-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tion of the latter wheel it will be one tooth behind the former wheel, and at the end of 100 rotations the former would have made a complete rotation relative to the latter. If the worm be cut with a single thread it would have to make 100 times 101, or 10,100 rotations in order to produce this result. This construction is used on certain counting devices. 134. Two bevel gears are connected by a pair of small bevel pinions mounted in a frame, as shown in the side elevation 1. If the gear wheels should be rotated at different velocities the frame would rotate at the mean velocity. 135. A rapidly rotating shaft carries a gear wheel eccentrically mounted thereon. The latter is carried along into engagement with a fixed internal gear or rack, and is thereby rotated at a slow speed. 136. Two concentrically mounted bevel gears of different diameters engage with a third bevel gear. The latter rotates at the mean of the velocities of the other two. 137. A hollow screw threaded into a frame is formed with an internal thread, of slightly different pitch, adapted to receive a smaller screw, which is so mounted in the frame that it may slide longitudinally, but cannot rotate. If the larger screw should have ten threads to the inch, and the smaller screw eleven, the latter would move outward one-eleventh part of an inch while the former was fed inward an inch.

138. Uniform rotary motion converted into reciprocating rectilinear motion. A rack frame arranged to slide longitudinally is engaged by a toothed sector which meshes with the teeth on one side of the rack to drive the frame forward, and then with the teeth on the other side to drive the frame back.

139. Variable speed gear for producing fast and slow motion. It comprises two pairs of toothed sectors so arranged as to properly mesh with each other. The driving gear shown at the right is provided with two arms which carry studs at their outer ends. These studs lie below the lower face of the gears and engage studs formed on the lower face of the driven gear, as shown in dotted lines, thus guiding the wheels after one pair of sectors have moved out of mesh and before the other pair have come into mesh with each other.

140. Mechanism for producing increased or decreased speed on the same line of shafting. A fixed bevel gear wheel, A, meshes with two bevel gear wheels, B, which in turn mesh with a pinion, E, carried on the right-hand shaft. The bevel wheels, B, are mounted in a bracket which turns freely on the shaft of pinion, E. Each wheel, B, carries a pinion, C, which meshes with a bevel gear wheel, D, carried by the left-hand shaft. The change of speed from one shaft to the other is due to the planetary movement of the wheels, B and C. When the multiple of the teeth in A and C exceeds that of B and D the shafts will rotate in opposite directions.

CAMS AND CAM MOVEMENTS.

141 and 142. Cylinder or Drum Cams.—In Figure 141 a groove is formed in the curved face of a cylinder or drum. A roller on the end of a pivoted arm fits into this groove. As the drum rotates the arm will be swung to various positions, guided by the groove in the cam. In Figure 142 the roller bears against the rim of the cylinder, which is made of such shape as to give the desired motion to the lever. In this form of cam, while the roller is positively moved down by the cam rim, it is raised up by a spring on the lever, which tends to hold it constantly against the cam. In the first type of cam the motion is positive in both directions.

143. Beveled Cam.—This form of cam is used to give motion to a lever whose axis lies at an angle with the cam-shaft. The cam is of conical form with curved edges against which the lever bears. In our illustration we have shown a sliding rod in place of a rocking lever. The conical face, it will readily be seen, must lie parallel with the plane of the rod.

144. Face Cam.—The cam groove is cut in the face of a disk, and this on being rotated guides the movement of the rocking lever which carries a roller that enters this groove.

145. Clover-leaf Cam.—This is a form of disk cam which gives a positive drive to a sliding lever. The cam acts between two rollers on the lever, and is so cut as to exactly fill the space between these rollers at all times.

146. Heart Cam.—Another form of disk cam. This is so cut as to give uniform rectilinear motion to a sliding rod which bears against its edge. To lay out this cam, divide the desired line of travel of the rod into any convenient number of equal spaces, starting from the center of the roller, and from the center of the cam describe arcs passing through the dividing points. Twice the number of radial lines should be laid off from the center of the cam, the lines being equally spaced angularly. The successive points of intersection of the radial lines and the arcs will then mark the centers for a series of arcs with radii equivalent to the radius of the roller. The curve drawn tangent to these arcs will then mark the outline of the cam.

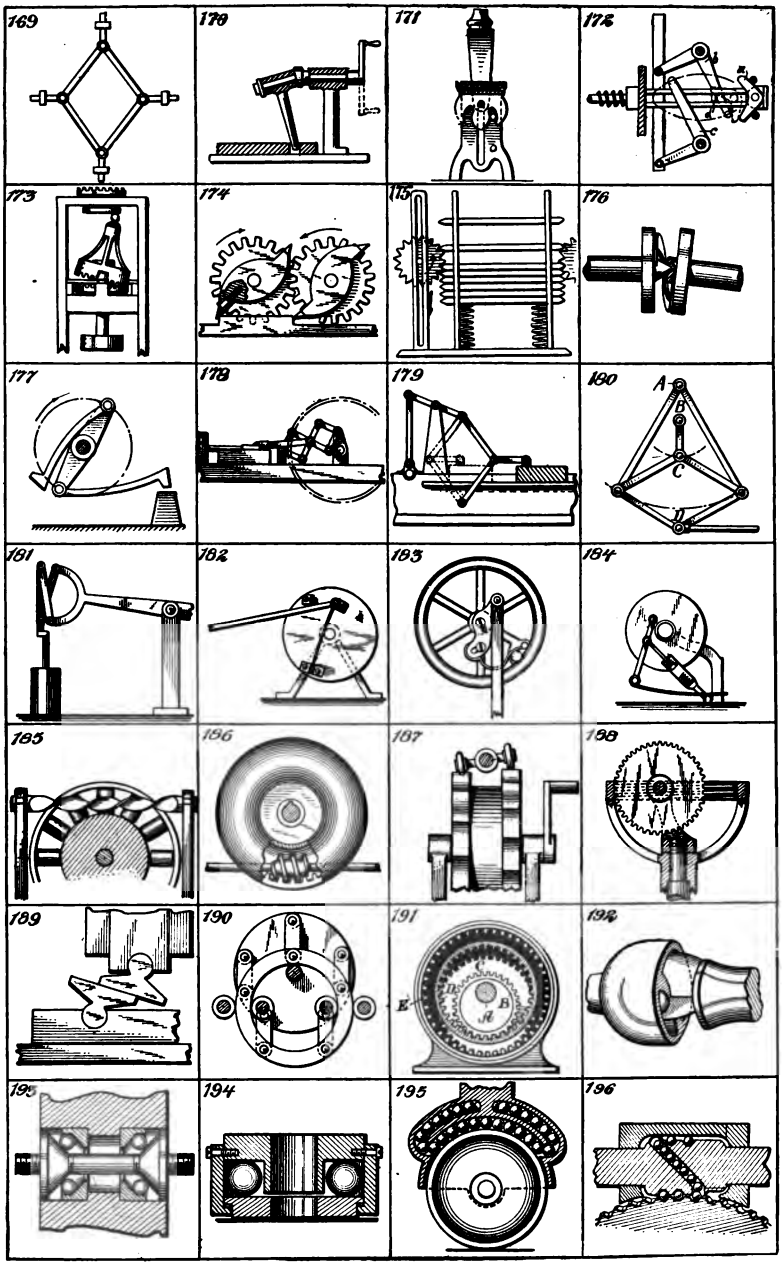
147. Means are here shown for converting rotary motion into alternating reciprocating motion of two rods. The rods are attached to pivoted levers carrying rollers which bear against the edges of two oval disk cams mounted on a rotating shaft.

148. Rotary motion is here converted into variable rectilinear motion. The end of a sliding lever rests on the irregular edge of a disk cam, and is there by caused to move up and down following the irregularities of the cam. The cam shown gives three reciprocations of the rod for each rotation of the cam shaft.

149. Means for converting rotary motion of a shaft into rocking motion of a lever. The lever is caused to rock by a cam with an oblique face on which the roller of the lever bears. This is a modification of the motion shown in Figure 142.

150. Means for converting rocking motion of a shaft into uniform rectilinear motion of a rod. The rod, which is mounted to slide in bearings, carries a pin which engages a slot in the cam on the rocking shaft. The cam slot is so cut as to give uniform motion to the rod.

151. Continuous rotary motion of a shaft is here converted into intermittent reciprocating motion of a slide. A cam lever hinged at its lower end to a fixed point is connected by a rod at its upper end, to the slide. A crank arm on the rotating shaft carries a pin which enters a curved slot in the cam lever. The crank arm causes the lever to rock, carrying the slide with it. The cam slot should form an arc with a radius equal to that of the crank arm, so that while the crank pin is passing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through this arc the slide will remain stationary. This motion is used on certain types of sewing machines and printing presses.

152. The type of cam used on the needle bars of some sewing machines. A pin on a rotating disk engages a slot in a cam yoke on the needle bar. This slot is formed with a curve at one place, which holds the bar stationary, while the pin is passing through it. This causes the needle to stop while the shuttle passes.

153. This cam motion differs from that of Figure 152, in that it causes the sliding bar to stop midway of its upward stroke and midway of its downward stroke. The cam slot comprises two parallel sections connected by two curved sections. While the pin on the rotating disk passes through the curved sections the bar is held stationary.

154. The cam here shown causes the sliding bar to stop at the end of each stroke. The cam is triangular, with curved faces, and rotates between the two parallel working faces of a cam frame on the sliding bar. While the outer face of the cam engages the frame the bar is held stationary. This is a form of cam motion used in place of an eccentric for operating the valve of a certain French engine.

155. A peculiar variable intermittent motion of the sliding rod is given by the planetary action of a cam mounted on a rotating disk. The cam shaft passes through the disk and carries a pinion which meshes with a stationary internal gear wheel.

156. A rectangular motion is imparted to the cam frame by two triangular curved cams mounted on a rotating shaft. The frame is mounted to slide laterally in bearings, which in turn are permitted to slide vertically in grooves on two stationary supports. The frame is made up of two horizontal rails on which one of the cams acts, and two vertical rails on which the other cam acts The illustration shows the frame about to be moved downward by the forward cam acting on the lower rail while the rear cam prevents any lateral movement. On the next quarter rotation of the cam shafts a lateral movement will ensue, due to the rear cam acting on the right-hand vertical rail. At the same time the forward cam will hold the frame against vertical movement. During the third quarter of the rotation the frame will be lifted, and during the last quarter it will be moved back laterally to the position illustrated. If the cams are both of the same size, the motion of the frame will trace a perfect square.

157. Means for converting rotary motion into vibrating motion. A forked lever engages opposite edges of a disk cam, and is thereby caused to vibrate. This cam, as that in Figure 145, is so cut that its opposite edges are everywhere equidistant when measured through the center. For this reason it is obvious that such a cam must always be cut with an odd number of projections.

158. A recently patented mechanism for imparting power to the dasher shaft of a churn. A rocking movement is imparted to the shaft from a rotating cam. At the upper end of the shaft is a forked piece or follower mounted to turn in a socket at right angles to the axis of the shaft. The follower engages a spline on the cam and is thereby guided first to one side, and then to the other of the cam, rocking the shaft on its axis.

159. Trammel Gear.—A reciprocating movement of the rod is produced by the rotation of a shaft, and *vice versa*. Pivoted to the rod are two blocks which slide respectively in two slots in the face of the disk which cross each other at right angles. This movement was patented seventy years ago, but is constantly being reinvented as a substitute for the crank.

160. Mechanism for converting rotary motion into reciprocating motion. This is a common form of eccentric used on steam engines, etc., for communicating a reciprocating motion to the valves from the crank shaft. The rod is provided with a circular strap which is bolted over a disk or ring eccentrically mounted on the crank shaft.

161. This form of eccentric is similar to that shown in Figure 160, but an oval cam frame or yoke is used in place of a circular strap, so as to produce a rectilinear reciprocating movement of the rod. This form of eccentric acts directly on the valve rod which travels between fixed guides.

162. Spiral Cam for converting rotary motion into reciprocating motion. The cam is formed with a flange or spline, disposed spirally on the curved face of the wheel. The spline engages a notch in a rod and gives the latter a reciprocating movement when the cam is rotated.

163. Elliptical Crank.—Two cranks are connected with a single pitman, the outer one, through a connecting link. The circular movement of the inner crank causes the outer end of the pitman to move in an elliptical orbit, thereby increasing its leverage at certain points.

164. A device for gripping a bar or cable. The bar travels between a fixed guide and the cam-shaped head of a lever. When the lever is thrown up, friction of the bar on the cam tends to rotate the latter until it becomes wedged between the cam and the fixed guide.

165. Lever Toggle-joint.—A device commonly used on letter-presses. One of the two connected arms is pivoted to the platen of the press and the other is hinged to a fixed standard. By lifting the lever on one of the toggle arms the arms will be brought into vertical alignment with each other, producing a powerful pressure on the platen.

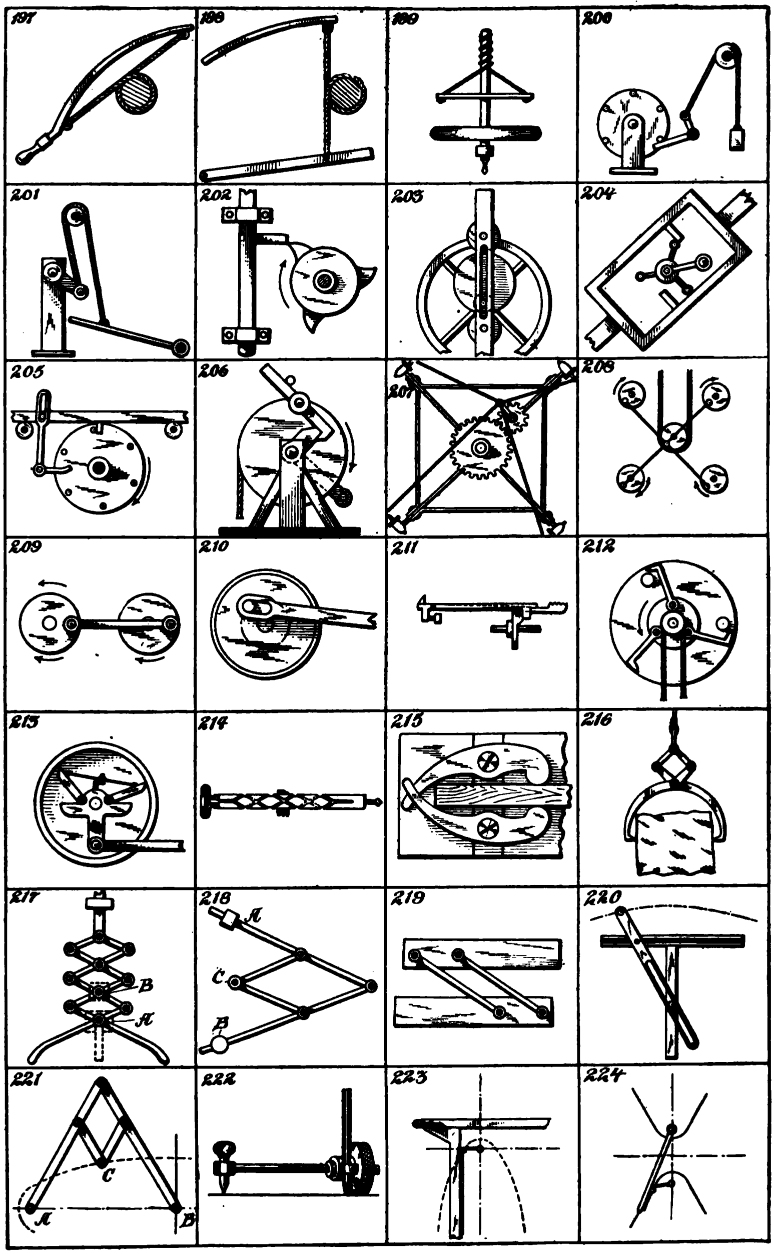
166. Screw Toggle Press.—Two toggle arms are hinged to the letter-press and at their outer ends are hinged to nuts on the feed screw. The screw is cut with right- and left-hand threads. so that when turned in operative direction it will draw the arms toward each other and press the platen downward.

167. Bell Crank Toe Levers.—Two bell crank levers are provided with projecting toes which bear against each other When one of these levers is swung on a center it causes the other to swing also, but at a variable speed, due to the varying leverage. This mechanism is used for a type of valve gear.

168. Wiper Cam.—A type of cam used on certain stamp mills to lift the hammer. The cam bears against a flanged collar on the hammer spindle, which permits the latter to rotate.

MISCELLANEOUS MOVEMENTS.

169. Device for transmitting reciprocating motion from one pair of rods to another pair lying at right angles thereto. The rods are all connected by links so that when two opposed rods are moved inward or toward each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other, the other two rods will be moved outward, and *vice versa*. Also if two adjacent rods be moved the one outward, and the other inward, the opposite rods will be moved one outward and the other inward respectively.

170. Means for converting rotary into reciprocating motion. A bent shaft carries at its outer end an arm which is loosely mounted thereon. The lower end of this arm engages a slot in a bar which is mounted to slide in suitable guides. As the bent shaft rotates, the arm which is prevented from rotating with the shaft is given a rocking movement in the direction of its axis, and thus imparts a reciprocating movement to the bar.

171. Movement used on hand stamps. The plate which carries the type normally lies face upward against an ink pad, and is formed with a flange at each end in which cam slots are cut. The type plate is pivoted in a yoke piece to which the handle is secured, the pivot pins passing through slots in the uprights of the frame. When the handle is depressed, the type plate is carried downward and at the same time rotated by engagement with two pins which operate in the cam slots so that the type will face downward when brought into contact with the paper. The parts are returned to normal position by a spring on release of the handle.

172. A peculiar device for alternately rocking a pair of levers by means of a reciprocating rod. The rod carries a bell crank lever, *A*. This lever is normally held in the position illustrated by two pins against which it is pressed by the spring-pressed rod. Two bell crank levers, *B* and *C*, connected by a bar, are hinged adjacent to the rod. With the parts in the position illustrated, when the rod is drawn forward, one arm of the bell crank, *A*, will engage a pin at the end of lever, *B*, and will be thereby turned until it engages a stop piece, *D*, on the rod, after which it will operate to swing bell crank, *B*, on its axis. Owing to the connection between the levers *B* and *C*, the latter will also be swung but in the opposite direction. On return of the rod the bell crank lever, *A*, is brought to normal position by the two position pins, and when next the rod is drawn forward, the other arm of lever *A* will engage a pin on lever *C*, returning both levers *B* and *C* to their original positions.

173. Mechanism for transmitting rotary motion at increased speed from one shaft to another in alignment therewith. The lower or driving shaft carries a crown wheel at its upper end which is engaged by a second crown wheel having universal joint connection with a stationary central post. The latter is supported from the frame by cross arms, which are adapted to engage slots cut in the second crown wheel, and thus prevent the wheel from rotating. The upwardly projecting frame of the second crown wheel is connected to a wheel on the upper shaft, but eccentric thereto, by means of a ball-and-socket joint. The driven crown wheel is thus tilted so as to engage the teeth of the driving wheel. As the latter rotates the driven wheel is given a rocking or wobbling movement, which rotates the upper shaft. A slight movement of the lower shaft thus produces a complete rotation of the upper shaft.

174. A device for converting reciprocating into rotary motion and *vice versa*. Two intermeshing gear wheels are provided with spring pawls oppositely disposed on the gears, and adapted alternately to snap into engagement with a lug on a reciprocating rod and thereby impart rotary motion to the gears.

175. A device for spacing apart a number of bars. The bars are arranged to slide with a certain amount of friction between guide pieces. Normally they are crowded together in a group by a pair of coil springs. A pair of rotating spur wheels whose teeth engage the pointed ends of the bars are mounted on either side to slide vertically in suitable guideways. The vertical movement of the gears carries the bars downward against the springs and the slow rotary movement of the gears successively releases the bars at regular intervals. The bars remain where released, being held by frictional engagement with the guide pieces.

176. An early form of flexible shaft coupling. One of the shafts is pointed and fits into a socket in the other shaft. Each shaft carries a collar and these are connected by a flat spiral spring.

177. Centrifugal hammer. Two hammers are hinged on a rapidly revolving disk. As the disk revolves, these hammers are alternately swung by the added force of gravity and of centrifugal action, on to the anvil. A very powerful stroke is thus given.

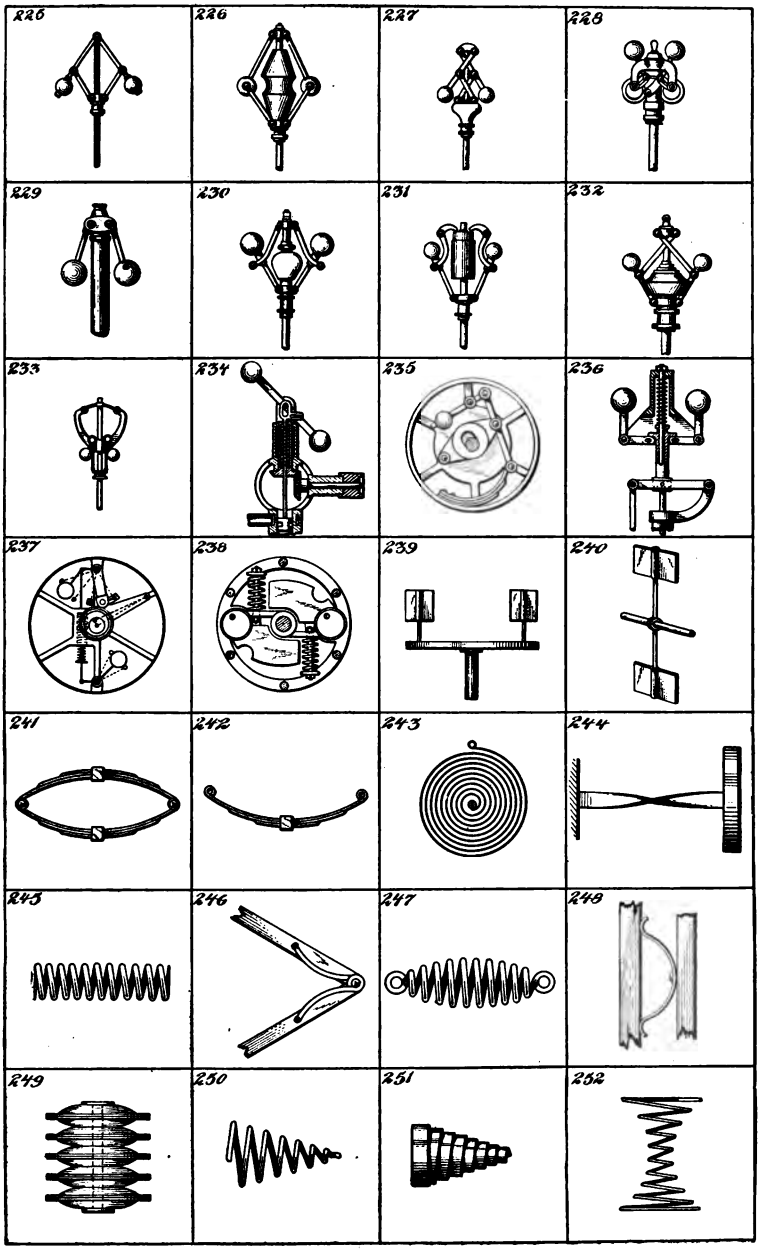
178. A device for communicating reciprocating motion of an engine to a rotating crank in such manner that the crank will have a greater throw than the stroke of the engine crosshead. The connecting rod acts on the crank shaft through a "lazy tongs" which multiplies the stroke and affords a better leverage upon the same.

179. A device for producing two rotations of the crank shaft of an engine at each complete (forward and return) stroke of the crosshead. The crosshead of the engine is connected by a rod to a pair of connected levers, one of which is pivoted on a fixed pin and the other to the working beam. Owing to the toggle action of the levers the working beam will rise and fall twice while the crosshead moves to its outer position and returns.

180. A device for converting rocking movement into rectilinear reciprocating movement, usually called "parallel" motion. Two links pivoted on the fixed pin *A* connect at their outer ends with two links pivoted on a rod at *D*. The latter links are also connected to a pair of links pivoted to a rock arm *C*. The distance between *A* and *B*, the fixed pivot of the rock arm, is equal to the distance between *B* and *C*. Owing to the fact that the double link-quadrangle swings on two pivots, it will be lengthened when swung out of the vertical position, thus giving a rectilinear motion to the rod *D*. This movement is called "Peaucellier's" parallel motion. It is used to give rectilinear movement to a pump rod or to the piston rod of an engine.

181. Another device for producing rectilinear movement of a pump rod. The rod, instead of being directly connected to the working beam of an engine, is connected thereto by cross links. This motion, however, is not a true "parallel motion," but the rod is strained by cross connection.

182 to 184. Devices for overcoming "dead" centers of cranks. In Figure 182 the pitman is connected to one end of a leaf spring, whose other end is connected to the crank disk. The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pitman is thus permitted to play between two socket lugs projecting from the face of the disk. Just before the back center is reached, the pitman slips out of engagement with the lower socket, by reason of the tensile strain on the spring, then on the return stroke, the connection of the spring being above the line of centers, the spring yields and throws the pitman back into the lower socket, and acts upon it to rotate the disk, until the forward center is reached, when the action will be the reverse of that just described. In 183 the pitman is attached to a plate secured to the flywheel at two points by screws passing through slots cut diagonally in the plate. In starting the wheel from either of its dead centers, the pitman will cause the plate to slide on its diagonal slots and the pitman will thus carry itself out of the dead center. The plate will then be returned to normal position by a spring. The device shown in 184 is specially applicable to machines operated by treadles. Attached to the pitman is a piston acting in a cylinder pivoted to the rod on which the treadle is hinged. Within the cylinder are two coil springs which alternately act on the piston to carry the crank over the two dead centers.

185. A device for transmitting motion from one shaft to another lying at right angles thereto. The driving shaft is formed with a spiral ribbon which acts between rollers radially mounted on a wheel, carried by the driven shaft. The wheel is formed with a double series of rollers, one on each side of the spiral shaft, but the forward series has been cut away in the illustration to show detail. The action is similar to that of a worm and worm wheel, but friction is reduced by the use of the rollers.

186. An internal worm gear is here shown which offers the same advantages as the internal spur gear, namely, that of greater strength due to the fact that the area of contact between the worm and the worm wheel is increased. The worm wheel is made up of two hollow sections, clamped together, but so spaced as to form a slot in the rim through which the worm shaft passes.

187. Means for converting rotary motion into rocking motion. The power shaft carries two cams formed with corrugated peripheries. On opposite sides of the rock shaft are two rollers, one for each cam. The cams are so spaced that when one roller is being lifted, the other will fall. Thus, a rocking motion is imparted to the rock shaft. The same effect may be produced by using a single broad cam for the two rollers, but spacing one roller a little in advance of the other on the rock shaft.

188. Another form of internal worm gear. A worm wheel is mounted on a stationary bracket and engages the spiral thread formed in a ring. As the ring revolves about the gear, the latter is caused to slowly rotate. As in Figure 186, a very strong construction and powerful transmission is afforded by this arrangement

189. A sliding toggle movement is here shown for producing great pressure in a direction at right angles to that of the impelling force. The toggle members are so mounted and are of such shape that they combine the action of the inclined plane with the ordinary toggle action.

190. Means for giving parallel movement to the paddles of steamboats, etc. The power shaft carries a disk which is connected by a series of hinged links with a ring held eccentrically to the shaft, between pairs of rollers. The paddles are attached to the links and are thereby kept parallel, while the disk and ring rotate. This same arrangement can be used to communicate motion to shafts lying out of alignment with each other, one of the shafts being attached to the ring.

191. Device for transmitting motion from one shaft to another at decreased velocity. The device is here shown diagrammatically. The driving shaft carries an eccentric *A*, upon which spur gears *B* and *C* are fitted to turn freely. The latter are permanently secured together. Wheel *B* meshes with internal gear *D*, on the driven shaft, and wheel *C* meshes with the stationary internal gear *E*. In operation the eccentric carries gear *C* about gear *E*, thereby causing it to rotate on its own center. The gear *B* will be revolved by the eccentric in one direction and be rotated in the opposite direction by the gear *C* to which it is attached, thus causing the gear *D* to move at a reduced speed,

192 to 196. Ball-bearing Devices.—In 192 is shown a ball-bearing knuckle joint consisting of a flanged socket member having sockets for the reception of steel friction balls, and a second member formed with flanges which bear against the friction balls. When the device is in operation, the balls will roll back and forth in their sockets at each rotation of the knuckle joint. In 193 a common form of ball-bearing is shown. The balls are held in stationary cups and bear against cones on the rotating shaft. 194 shows an end-thrust ball bearing of common form. 195 shows a ball-bearing wheel or caster. The balls are arranged to travel over an endless path, being guided from the forward end of the wheel bearing, through a passageway in the body of the caster, to the rear of the wheel bearing surface. 196 shows the same principle applied to a worm and worm wheel. The thread of the worm does not engage the teeth of the worm wheel, but communicates motion thereto through a series of balls. The latter, when they reach the end of the worm thread, are guided back through a passageway in the worm body to the beginning of the thread.

197. Means for converting reciprocating rectilinear movement into reciprocating rotary movement. A primitive form of turning lathe. The wooden shaft or other object to be turned, is mounted to rotate freely between pivot pins. A rope coiled about the shaft has its free ends secured to a spring bow. In operation, the handle of the bow is seized in one hand, and the other hand holds the tool against the work, which is rotated first in one direction, and then in the other, by moving the bow back and forth.

198. This is another form of primitive lathe which, however, is adapted to be driven by foot power. The rope, which is wound around the shaft is secured at its upper end to a spring, usually the end of a thin board, and at its lower end to a pedal. When the latter is depressed, the shaft will rotate toward the cutting tool and on its release the spring will cause it to rotate back, ready for the next downward stroke of the pedal. This type of

lathe is still commonly used in some Eastern countries.

199. An ancient form of drill, but one which is still used by jewelers. Coiled about the spindle of the drill are two cords whose lower ends are secured to a cross piece mounted to slide up and down on the spindle. When the cross piece is pressed downward, it causes the cords to uncoil, rotating the spindle. When the cross piece reaches the bottom of its stroke the pressure on it is relieved, and due to the momentum of a heavy flywheel on the spindle, the latter continues to rotate, recoiling the cords and lifting up the cross piece. On the next downward stroke of the cross piece, the spindle will rotate in the opposite direction.

200. Trip hammer. A rotating disk is formed with a series of pins adapted consecutively to depress one arm of a bell crank to the opposite arm of which a hammer weight is connected by a cord. When the bell crank clears a pin on the disk, the weight drops, delivering the blow, and is then lifted again by the next pin acting on the bell crank.

201. Means for converting reciprocating motion into rotary motion. A rope attached at one end to a foot pedal passes over an intermediate pulley, and is attached at the other end to the weighted crank arm of a shaft. The arrangement is such that on the downward or power stroke of the pedal, the weighted arm will be lifted to the vertical position, when it will be assisted by gravity and its own momentum to continue its rotation and lift the pedal for the next downward stroke.

202 to 205. Means for converting rotary motion into rectilinear motion. In 202, secured to a rotating shaft is a cam formed with projecting horns, which are adapted to successively engage a lug on a sliding rod. The rod is thereby given a trip-hammer movement, dropping by gravity as the lug clears the horns. In 203, a disk mounted eccentrically on a rotating shaft is engaged on opposite sides by a pair of rollers, pivoted to a rod. As the shaft rotates, the rod will be moved up and down, following the eccentric movement of the disk. This movement is used on windmills to transmit motion from the rotating windmill shaft to the pump rod. In 204 a shaft is provided with radial arms bearing rollers at their outer ends. These are adapted to operate within a frame mounted to slide, and formed with two lugs diagonally disposed on opposite sides of the frame. When the shaft is rotated, by means of the crank arm shown, the frame will be moved first to one side by one of the rollers engaging one of the lugs, and then in the opposite direction by another of the rollers moving into engagement with the other lug. In 205, a sliding carriage is formed with a lug adapted to be engaged successively by a series of pins on a revolving disk. The carriage will be moved forward by one of the pins until the latter clears the lug, when the carriage will be moved back again by another pin engaging an arm of a bell crank whose other arm engages the carriage.

206. Automatic release for a winding drum. A winding drum is mounted to turn freely on a shaft. A hook is pivoted on the face of the drum, and when it is desired to rotate the drum the hook is brought into engagement with a tappet on the shaft. When, however, the weight has been raised to a predetermined position by the winding drum, a pin strikes the hook, releasing it from engagement with the tappet and permitting the weight to drop.

207. An amusement device called the "Flying Horse" used in parks and fairs. A frame mounted to rotate on a vertical spindle, is provided with a simple gear wheel, which meshes with a driving pinion. By alternately pulling the cords, radiating from a crank on the shaft which carries the pinion, the persons occupying the seats or horses at the corners of the frame, are enabled to keep the apparatus in motion.

208. This figure shows a single pulley driving four other pulleys by means of a cross-shaped connecting rod. This form of drive is occasionally used for rotating wheels or cylinders which lie so close to each other that no gearing or other mechanism for transmitting motion can be used.

209. This figure illustrates the rather curious fact that if two wheels are coupled together by a connecting rod, whose crank pins are respectively equally distant from the centers of the wheels, then while one wheel is constantly rotated in one direction the other may be rotated in the same direction, or in the opposite direction, as desired.

210. A stop motion used in brick machines for drawing the mold back and forth, and bringing it to rest at each stroke to permit of depositing the clay and removing the brick. A rotating wheel carries a crank pin which engages a slot in a connecting rod. At the end of its forward stroke, and at the end of its return stroke the connecting rod will remain stationary, while the crank pin moves from one end of the slot to the other.

211. A device used in sewing machines for feeding the goods under the needle. The feed bar is formed with teeth at one end and the opposite end is pivoted between the arms of a forked lever. The feed bar is lifted by a peripheral projection on a cam, and at the same time the forked lever is moved forward by a projection on the side face of the cam, which bears against a lug carried on the lever. A spring at the opposite end of the lever normally holds the lug in contact with the face of the cam.

212. Elevator safety device. Secured to the side of the elevator shaft is a plate formed with one or more studs. To the winding drum of the elevator a number of hooks are pivoted. When the drum rotates the hooks are thrown out by centrifugal action, and if dangerous speed is acquired, they swing out far enough to catch hold of one or more of the studs, bringing the drum to a stop. The shock of the sudden stoppage is usually taken up by a coil spring on the drum.

213. A device for converting oscillating motion of a lever into intermittent rotary motion. A crank arm which is provided with two pawls hinged to its upper end, is oscillated within the rim of a wheel. The pawls are connected by a cord to a small crank, which may be turned so as to bring one pawl into frictional engagement with the rim of the wheel, and thereby cause the wheel to rotate intermittently. When it is desired to reverse the direction of rotation, the crank is turned, raising the first pawl and bringing the other one into engagement with the wheel.

214. Means for converting rectilinear motion into rotary motion. This is used on certain forms of drill stocks. The drill stock is cut with two spiral grooves, one of which

is left-handed and the other right-handed. A ring on the drill stock is provided with a follower which follows one of the grooves on the forward stroke, and the other groove on the return stroke, thus causing the drill to turn always in the same direction.

215. An automatic bench clamp, used by carpenters for holding the work while planing, etc. Pivoted to the work bench are two cam levers, formed with curved ends, which are moved apart by the work as it is pressed in between them, thus causing the clamping ends of the levers to tightly grip the work.

216. Gripping tongs for lifting stones and the like. The upper arms are connected to a shackle by a pair of links so that when a pull is exerted on the shackle, the arms are drawn together, pressing the points into the stone; the heavier the stone lifted the more tightly will the arms be drawn together, thus increasing the grip on the stone.

217. A series of cross connected levers used for multiplying or reducing motion. In the illustration, the lowest pair of levers is pivoted to a fixed pin *A*, and the arrangement is such that if one pair of the crossed levers be folded together, the entire series will fold, giving the rod attached to the upper pair of levers a greatly multiplied longitudinal movement, and conversely if the rod be moved, a greatly reduced motion will be given to the lower pair of links. The extent to which the motion is multiplied or reduced is directly proportional to the number of pairs of levers in the series. This device is called a "lazy tongs." The figure also shows a means for multiplying motion imparted from one rectilinear reciprocating rod to another. If the fixed pivot of the lazy tongs be at *B*, on giving reciprocating motion to the lower rod, the reciprocating motion will be imparted to the upper rod, but the travel of the upper rod will be twice that of the lower rod.

DRAFTING DEVICES.

218. A pantograph, or an instrument for reproducing a drawing on a larger or smaller scale. It comprises two levers hinged together and connected by a pair of hinged links. One of the levers carries a slide, *A*, in which a pencil is secured. The other lever carries a pivot pin, and the tracing point is located at *C*. In use the device is made to turn on the fixed point at *B*, then on moving the tracing point *C* over a drawing, the same will be reproduced by the pencil at *A*. By varying the positions of the pencil and the pivot pin on their respective levers, the reproduction may be made larger or smaller than the original as desired.

219. This figure shows the "parallel ruler," a device used for drawing parallel lines. Two parallel rulers are connected by a pair of parallel links of equal length. The rulers will then always lie parallel to each other, whether swung apart or moved together.

220. A device for drawing a conchoid curve. A conchoid curve may be described as a curve of such form that when measured along lines drawn from a fixed point called the pole, it will, at all points, be equidistant from a straight line, called the asymptote. The device shown comprises a T-square with grooved head-piece adapted to receive a slide pivoted to a bar. A slot in the lower end of this bar engages a pin on the blade of the T-square and the opposite end of the bar carries the scribing pencil. The pin represents the pole and the grooved head of the T-square represents the asymptote. The curve traced by the pencil when measured along the bar lies everywhere equidistant from the asymptote.

221. An ellipsograph or a device for drawing ellipses. This is similar to the pantograph shown in Figure 218. The fixed pivot, however, is at *B*, the tracing point at *A*, and the pencil at *C*. When *A* is moved in a straight line toward or away from *B*, the pencil *C* will trace an elliptical curve.

222. A device for drawing a helical curve. A rod provided with a pivot point is threaded to receive a nut with a milled flange. As the rod is moved about ts center, the nut is rotated by a frictional contact of the flange with the drawing paper, and is thus slowly fed toward or away from the center. A pencil carried by a sleeve on this nut will then trace a helical curve.

223. A device for describing parabolas. A pin is placed at the focus of the desired parabola and a straight-edge is placed on the line of the directrix. A slack cord is secured at one end to the pin, and at the other to the blade of a square whose stock bears against the straight edge. The slack of the cord is taken up by the pencil, which bears against the blade of the square. Sufficient slack is provided to make the distance of the pencil from the focus equal to its distance from the straight-edge or directrix. The curve then described by the pencil while keeping the cord taut against the square, as the square is moved along the straight-edge, will be a parabola.

224. A device for describing hyperbolas. The two pins shown represent the foci of two opposite hyperbolas. A ruler turns on one of these pins as a center, and its opposite end is connected with the other pin by a slack cord. The slack of the cord is taken up by the pencil which bears against the ruler. The curve described will then fulfil the conditions of a hyperbolic curve, which requires that the distance from any point in the curve to its focus, minus the distance from that point to any other fixed point or focus, should always be a constant quantity.

GOVERNORS.

A governor of a steam engine is a device for automatically operating the throttle, or for shortening the stroke of the slide valve when the engine attains a dangerous speed.

225. WATT'S GOVERNOR.—When a dangerous speed is acquired, the centrifugal force acting upon a pair of balls tends to lift a sleeve which, through a bell crank, operates the throttle.

226. PORTER'S GOVERNOR.—The operation is very similar to that of Watt, but the balls are required to lift a weight which may be adjusted as desired.

227. KLEY'S CROSS ARM GOVERNOR.—The degree of sensitiveness is governed by the length of the cross arms, and also by an adjustable weight, which is lifted by the balls.

228. BUSS' GOVERNOR.—Two pairs of balls are used, one pair acting to counterbalance the other.

229. TANGYE'S GOVERNOR.—The balls when thrown out by centrifugal action depress a rod in the hollow central shaft and this rod acts directly on the block in the link thus shortening the stroke of the slide valve.

230 and 231. PROELL'S GOVERNOR.—In 230 the balls, aside from lifting a weight, act to compress a spiral spring. In 231 the outward movement of the balls is controlled by an air dashpot.

232. COSINE GOVERNOR.—A cross arm governor which acts to raise a weight.

233. PARABOLIC GOVERNOR.—The balls move on parabolic guide arms, which modify the effect of the centrifugal force, and produce equal valve movement, which is exactly proportional to the speed of the engine.

234. OSCILLATING LEVER GOVERNOR.—The balls are secured to the ends of a lever, which assumes a more horizontal position as the speed of the engine increases. A spring normally holds the arm in the tilted position illustrated.

235. SWEET'S FLYWHEEL GOVERNOR.—The centrifugal action of the ball moves the eccentric toward the center, thus reducing the stroke of the slide valve. A leaf spring resists the centrifugal action of the ball.

236. HARTNELL'S EXPANSION GOVERNOR.—The balls are thrown out by centrifugal force against the action of a spring raising the block in the link and thus varying the stroke of the valve.

237. HARTNELL'S CRANK SHAFT GOVERNOR.—The weights operate against the spring to move a toothed sector, which moves the eccentric toward the center of the crank shaft, thus varying the stroke of the slide valve.

238. TURNER'S CRANK SHAFT GOVERNOR.—The weights have bearings in the side plates of the governor. They also carry pins by which they are connected to the eccentric. When the weights are thrown out by centrifugal action, they move the eccentric toward the center of the crank shaft.

239 and 240. VANE GOVERNORS.—The shaft is prevented from rotating too rapidly by the atmospheric resistance acting on a pair of vanes. This resistance may be varied by adjusting the vanes to different angles. In some types of vane governors the inclined vanes serve to lift a sleeve, cutting off the supply of power.

SPRINGS.

241 and 242. LAMINATED OR CARRIAGE SPRINGS, used on carriages to take up the jolts of the wheels in passing over uneven roads. 241 shows the elliptical form, and 242 the semi-elliptical form. They are built up of flat spring metal strips.

243. WATCH OR CLOCK SPRING, used to drive a watch or clock train. The spring is formed of a flat spring metal strip, wound into a flat coil.

244. RIBBON SPRING.—A strip of flat spring metal mounted to exert a torsional pressure.

245. SPIRAL SPRING.—A length of round spring wire wound into spiral form. This spring could be used either as a tension or as a compression spring, though usually it has the form shown in Figure 247 when used as a tension spring. A spiral spring should never be extended or compressed more than one-third of its length.

246. SEAR SPRING.—This spring gets its name from its use in gun locks for causing the sear to catch in the notch of the tumbler. However, the spring is here shown as holding apart the arms of a compass.

247. TENSION SPIRAL SPRING.—A spiral spring which tapers toward the ends so that the pull will come centrally on the spring, thus giving an even tension and avoiding side strains.

248. FLAT OR LEAF SPRING.—A strip of flat spring metal used chiefly as a compression spring. A spring of this type is apt to lose its resiliency after continued use.

249. DISK SPRING.—A compression spring made up of a series of dished disks or plates.

250. HELICAL SPRING.—This spring differs from the spiral spring, Figure 245, in that it is formed by being wrapped around a cone, whereas a spiral spring is formed by being wrapped around a cylinder. The helical spring may safely be compressed until it lies flat like a clock spring.

251. VOLUTE SPRING.—A compression spring formed by coiling a flat spring ribbon into a helix.

252. FURNITURE SPRING.—A compression spring comprising a double helical spring used in furniture to support the cushioned backs or seats of chairs. This spring is also used in bed springs.

TRANSMISSION OF POWER BY BELTING.

THE TENACITY OF GOOD NEW BELT LEATHER varies from 3,000 lb. to 5,000 lb. per square inch of sectional area.

THE COEFFICIENT OF FRICTION between ordinary belting and cast-iron pulleys is about .423.

THE THICKNESS OF BELTS varies from three-sixteenths to five-sixteenths of an inch, or an average of one-fourth of an inch.

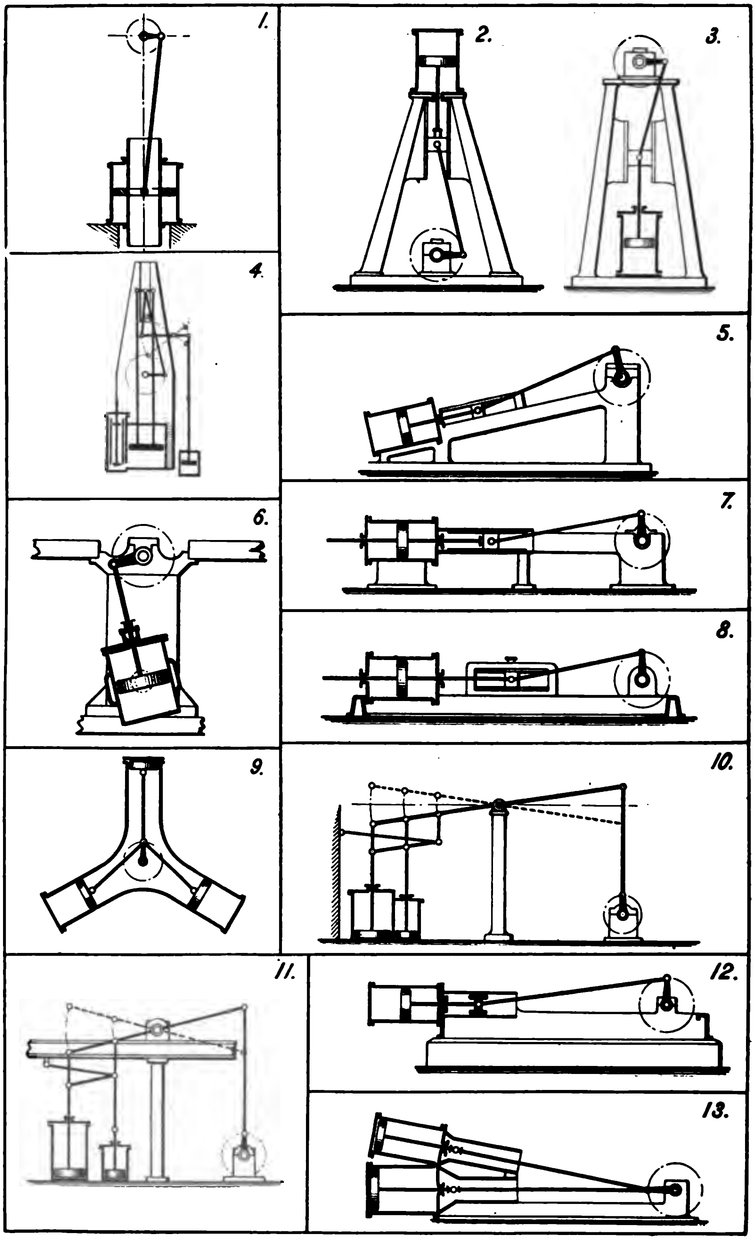
TENACITY OF RIVETING AND LACING.—The ultimate tenacity of good single leather belting may be taken at about 1,000 lb. per inch in width; the corresponding strength of a riveted joint being about 400 lb., a butt laced joint about 250 lb., and an ordinary overlap laced joint 470 lb. It is not customary, however, to allow an effective strain of more than one-fourth these amounts.

WORKING STRESS OF BELTS.—The following are the effective working stresses allowed for the different kinds and thicknesses of belts referred to in the table of powers.

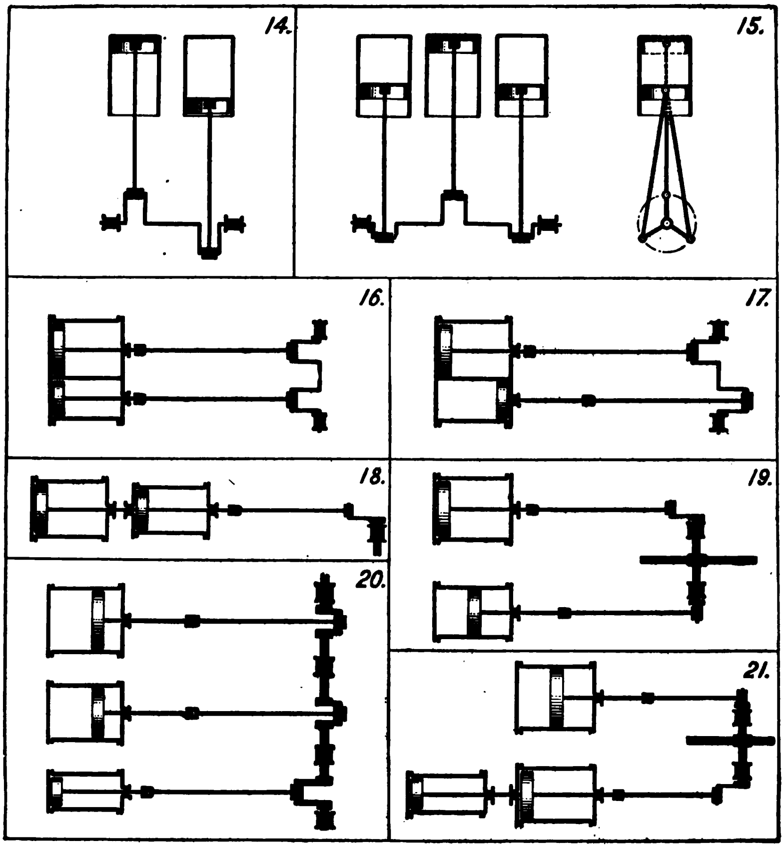
Ordinary single belts,	50 lb.
Light double belts,	70 lb.
Heavy double belts,	90 lb.
Link belts, $\frac{3}{8}$ in. thick,	42 lb.
" " $\frac{1}{2}$ in. "	48 lb.
" " $\frac{5}{8}$ in. "	57 lb.
" " $\frac{3}{4}$ in. "	66 lb.
" " $\frac{7}{8}$ in. "	78 lb.
" " 1 in. "	90 lb.

SPEED OF BELTING.—On ordinary shop line shafts the velocity of the belts varies from 1,000 ft. to 1,500 ft. per minute. Lathe belts vary from 1,500 ft. to 3,000 ft. per minute.

STRESS ON SHAFTING.—The cross stress on shafting arising from the sum of the tension on the two sides of the belt may be taken at 90 lb. per inch in width.—Practical Electrical Engineers' Pocket Book and Diary.



—From Haeder & Powles' Handbook on the Steam Engine.



—From Haeder & Powles' Handbook on the Steam Engine.

TYPES OF ENGINES.

1. Trunk Engine.
2 and 3 Vertical Engines.
4. Steeple Engine.
5. Inclined Frame Engine.
6. Oscillating Engines.
7. Corliss Frame or Girder Engine.
8. Horizontal Engine.
9. Radial Engine.
10. Beam Engine.
11. Beam Engine
12. Self Contained Horizontal Engine.
13. Inclined Cylinder Engine.
14. Double Cylinder with Cranks opposite or at 180°.
15. Three Cylinder Engine with Cranks at 120°.
16. Compound Woolf Engine with Cranks together.
17. Compound Woolf Engine with Cranks opposite or at 180°.
18. Compound Tandem Engine with Receiver.
19. Compound Engine with Cylinders side by side and Cranks at 90°.
20. Triple Expansion Engine, Cylinders side by side and Cranks at 120°.
21. Triple Expansion Engine, semi-tandem: Two Cranks at 90°.

PART III.

CHAPTER I.

CHEMISTRY.

TABLE OF ELEMENTS.*

Elements.	Discoverer.	Year.
Antimony	Valentine	1450
Bismuth	Valentine	1450
Zinc	Paracelsus	1520
Phosphorus	Brandt	1669
Arsenic	Schröder	1694
Cobalt	Brandt	1733
Nickel	Crondstadt	1751
Hydrogen	Cavendish	1766
Nitrogen	Rutherford	1772
Manganese	Gahn	1774
Oxygen	Priestley	1774
Tungsten	d'Elihujar	1781
Molybdenum	Hjelm	1782
Tellurium	Reichenstein	1782
Uranium	Klaproth	1789
Titanium	Klaproth	1795
Chromium	Vauquelin	1797
Tellurium	Klaporth	1798
Columbium	Hatchett	1801
Tantalum	Hatchett & Ekeburg	1802
Palladium	Wollaston	1803
Osmium	Tennant	1803
Cerium	Berzelius, Hisinger & Klaproth	1803
Iridium	Tennant	1804
Rhodium	Wollaston	1804
Potassium	Davy	1807
Sodium	Davy	1807
Barium	Davy and Berzelius & Pontin	1808
Strontium	Davy	1808
Magnesium	Davy	1808
Calcium	Davy and Berzelius & Pontin	1808
Boron	Davy and Gay-Lussac & Thénard	1808
Chlorine	Davy	1810
Fluorine	Ampère	1810
Iodine	Courtois	1811
Selenium	Berzelius	1817
Cadmium	Hermann & Stromeyer	1817
Lithium	Arfvedson	1817
Silicon	Berzelius	1823
Zirconium	Berzelius	1824
Bromine	Balard	1826
Thorium	Berzelius	1828
Yttrium	Wöhler	1828
Glucinum	Wöhler	1828
Aluminum	Wöhler	1828
Vanadium	Sefstroem	1830
Lanthanum	Mosander	1841
Didymium	Mosander	1841
Erbium	Mosander	1843
Terbium	Mosander	1843
Niobium	(same as Columbium, q. v.)	1844
Ruthenium	Claus	1844
Rubidium	Bunsen	1860
Cæsium	Bunsen & Kirchhoff	1860
Thallium	Crookes and Lamy	1862
Indium	Reich & Richter	1863
Gallium	Boisbaudran	1875
Ytterbium	Marignac	1878
Samarium	Boisbaudran	1879
Scandium	Nilson	1879
Thulium	Cleve	1879
Neodymium	Welsbach	1885
Praseodymium	Welsbach	1885
Gadolinium	Marignac	1886
Germanium	Winkler	1886
Argon	Rayleigh & Ramsay	1894
Krypton	Ramsay & Travers	1897
Neon	Ramsay & Travers	1898
Coronium	Nasini	1898
Xenon	Ramsay	1898
Victorium	Crookes	1898
Etherion (?)	Brush	1898
Polonium	Curié (Mrs.)	1898
Radium	Curiés (Mrs. & Mr.) and Bémont	1898
Actinium	Debierne	1899
(Must not be confounded with Phipson's actinium.)		
Asterium hydrogen	Lockyer	1899
(New) unknown.		
Thorium α	Brauner	1900
Thorium β	Brauner	1900
Krypton II	Ladenberg & Krugel	1900
Austrium II. (?)	Pribram	1900
Carolinium	Baskerville	1900
Radio-active lead (?)	Hoffmann & Strauss	1900
"Σ" Europium	Demarçay	1901
Euxenium earth (?) I. & II.	Hoffmann & Prandtl	1901
Amarillium (?)	Courtis	1902
Tellurium X	Pellini	1903
Berzelium	Baskerville	1903

Revised by Professor Charles Baskerville, Ph.D., of the University of North Carolina.

* Gold, silver, tin, copper, iron, lead, mercury, and carbon have been known from the earliest times.

INTERNATIONAL ATOMIC WEIGHTS.

Elements.	Symbol.	O=16.	H=1.	Elements.	Symbol.	O=16.	H=1.
Aluminum	Al	27.1	26.9	Neodymium	Nd	143.6	142.5
Antimony	Sb	120.2	119.3	Neon	Ne	20	19.9
Argon	A	39.9	39.6	Nickel	Ni	58.7	58.3
Arsenic	As	75.0	74.4	Nitrogen	N	14.04	13.93
Barium	Ba	137.4	136.4	Osmium	Os	191	189.6
Bismuth	Bi	208.5	206.9	Oxygen	O	16.00	15.88
Boron	B	11	10.9	Palladium	Pd	106.5	105.7
Bromine	Br	79.96	79.36	Phosphorus	P	31.0	30.77
Cadmium	Cd	112.4	111.6	Platinum	Pt	194.8	193.3
Caesium	Cs	132.9	131.9	Potassium	K	39.15	38.86
Calcium	Ca	40 1	39.8	Praseodymium	Pr	140.5	139.4
Carbon	C	12.00	11.91	Radium	Ra	225	223.3
Cerium	Ce	140.25	139.2	Rhodium	Rh	103.0	102.2
Chlorine	Cl	35.45	35.18	Rubidium	Rb	85.4	84.8
Chromium	Cr	52.1	51.7	Ruthenium	Ru	101.7	100.9
Cobalt	Co	59.0	58.56	Samarium	Sm	150	148.9
Columbium	Cb	94	93.3	Scandium	Sc	44.1	43.8
Copper	Cu	63.6	63.1	Selenium	Se	79.2	78.6
Erbium	Er	166	164.8	Silicon	Si	28.4	28.2
Fluorine	F	19	18.9	Silver	Ag	107.93	107.12
Gadolinium	Gd	156	155	Sodium	Na	23.05	22.88
Gallium	Ga	70	69.5	Strontium	Sr	87.6	86.94
Germanium	Ge	72.5	71.9	Sulphur	S	32.06	31.83
Glucinum	Gl	9.1	9.03	Tantalum	Ta	183	181.6
Gold	Au	197.2	195.7	Tellurium	Te	127.6	126.6
Helium	He	4	4	Terbium	Tb	160	158.8
Hydrogen	H	1.008	1.000	Thallium	Tl	204.1	202.6
Indium	In	114	113.1	Thorium	Th	232.5	230.8
Iodine	I	126.85	125.90	Thulium	Tm	171	169.7
Iridium	Ir	193.0	191.5	Tin	Sn	119.0	118.1
Iron	Fe	55.9	55.5	Titanium	Ti	48.1	47.7
•Krypton	Kr	81.8	81.2	Tungsten	W	184	182.6
Lanthanum	La	138.9	137.9	Uranium	U	238.5	236.7
Lead	Pb	206.9	205.35	Vanadium	V	51.2	50.8
Lithium	Li	7.03	6.98	Xenon	Xe	128	127
Magnesium	Mg	24.36	24.18	Ytterbium	Yb	173.0	171.7
Manganese	Mn	55.0	54.6	Yttrium	Yt	89.0	88.3
Mercury	Hg	200.0	198.5	Zinc	Zn	65.4	64.9
Molybdenum	Mo	96.0	95.3	Zirconium	Zr	90.6	89.9

REPORT OF THE INTERNATIONAL COMMITTEE ON ATOMIC WEIGHTS.

The International Committee on Atomic Weights has the honor to offer the following report:

In the table of atomic weights for 1904 only two changes from 1903 are recommended. The atomic weight of caesium has been slightly modified to accord with the recent determinations by Richards and Archibald, and that of cerium in conformity with the measurements by Brauner. The value for lanthanum is still in controversy, and any change here would therefore be premature. The same consideration may also be urged with regard to iodine. Ladenburg has shown that the accepted number for iodine is probably too low, but other investigations upon the subject are known to be in progress, and until they have been completed it would be unwise to propose any alteration.

Many of the atomic weights given in the table are well known to be more or less uncertain. This is especially true with respect to the rarer elements, such as gallium, indium, columbium, tantalum, etc. But some of the commoner elements also stand in need of revision, and we venture to call attention to a few of these. Among the metals, the atomic weights of mercury, tin, bismuth and antimony should be redetermined, for the reason that the existing data are not sufficiently concordant. Palladium also, on account

of discrepancies between different observers, and possibly vanadium, for which the data are too few, deserve attention. Among the non-metals, phosphorus has been peculiarly neglected; and our knowledge of the atomic weight of silicon rests upon a single ratio. In the latter case, confirmatory data are much to be desired. Upon any of these elements new investigations would be most serviceable.

There is one other point to which we may properly call attention. Many of the ratios from which atomic weights have been calculated, were measured in vessels of glass, by processes involving the use of strong acids. In such cases the solubility of the glass becomes an important consideration, even when no transfer of material from one vessel to another has occurred. A slight conversion of silicate into chloride would cause an increase of weight during the operation, and so introduce an error into the determination. Such errors are doubtless very small, and still they ought not to be neglected. Now that vessels of pure silica, the so-called quartz-glass, are available for use, they might well replace ordinary glass in all processes for the determination of atomic weights. An investigation into the relative availability of the two kinds of glass is most desirable.

(Signed) F. W. CLARKE,
T. E. THORPE,
KARL SEUBERT,
HENRI MOISSAN,
Committee.

CHEMICAL SUBSTANCES AND THEIR COMMON NAMES.

Common Names.	Chemical Names.
Alum	Sulphate of aluminum and potassium
Aqua fortis	Nitric acid
Aqua regia	Nitro-hydrochloric acid
Calomel	Mercurous chloride
Carbolic acid	Phenol
Caustic potash	Potassium hydrate
Caustic soda	Sodium hydrate
Chalk	Calcium carbonate
Copperas	Sulphate of iron
Corrosive sublimate	Mercuric chloride
Cream of tartar	Bitartrate of potassium
Epsom salts	Magnesium sulphate
Fire damp	Light carbureted hydrogen, methane
Glauber's salt	Sodium sulphate
Grape sugar	Glucose
Goulard water	Basic acetate of lead
Iron pyrites	Sulphide of iron
Jewelers' putty	Oxide of tin
Laughing gas	Nitrous oxide
Lime	Calcium oxide
Lunar caustic	Silver nitrate
Mosaic gold	Bisulphide of tin
Muriatic acid	Hydrochloric acid
Plaster of Paris	Calcium sulphate
Realgar	Sulphide of arsenic
Red lead	Oxide of lead
Rochelle salt	Sodium potassium tartrate
Sal ammoniac	Ammonium chloride
Salt, common	Sodium chloride
Salt of tartar (potash)	Potassium carbonate
Saltpetre	Potassium nitrate
Salts of lemon	Oxalic acid
Slaked lime	Calcium hydrate
Soda, washing	Sodium carbonate
Soda, baking	Sodium bicarbonate
Soda	Sodium carbonate
Spirits of hartshorn	Ammonia, solution of
Spirits of salt	Hydrochloric acid
Sugar of lead	Lead acetate
Tartar emetic	Potassium antimony tartrate
Verdigris	Basic acetate of copper
Vermilion	Sulphide of mercury
Vinegar	Dilute acetic acid
Vitriol, blue	Copper sulphate
" green	Ferrous sulphate
" oil of	Sulphuric acid
" white	Zinc sulphate
Volatile alkali	Ammonia

—*Knowledge Year Book.*

SPECIFIC GRAVITY.

To Convert Degrees Baumé into Specific Gravity.—(1) For liquids heavier than water: Subtract the degree of Baumé from 145 and divide into 145. The quotient is the specific gravity.

(2) For liquids lighter than water: Add the degree of Baumé to 130 and divide it into 140. The quotient is the specific gravity.

To Convert Specific Gravity into Degrees Baumé.—(1) For liquids heavier than water: Divide the specific gravity into 145 and subtract from 145. The remainder is the degree of Baumé.

(2) For liquids lighter than water: Divide the specific gravity into 140 and subtract 130 from the quotient. The remainder will be the degree of Baumé.

COMPARISON OF DEGREES TWADDELL AND SPECIFIC GRAVITY.

In order to change degrees Twaddell into specific gravity, multiply by 5, add 1,000 and divide by 1,000.

Example: Change 168 deg. Twaddell into specific gravity.

$$\begin{array}{r} 168 \times 5 \\ \hline 840 \\ 1{,}000 \\ \hline 1{,}000)1{,}840 \\ \hline 1.84, \text{ specific gravity.} \end{array}$$

To change specific gravity into degrees Twaddell, multiply by 1,000, subtract 1,000 and divide by 5.

Example: Change 1.84 specific gravity to degrees Twaddell.

$$\begin{array}{l} 1.84 \times 1{,}000 \\ 1{,}840 \\ 1{,}000 \\ \hline 5)840 \\ \;168° \text{ Tw.} \end{array}$$

SPECIFIC GRAVITY.

Determination of Specific Gravity:

Solids: (1) Solids heavier than, and insoluble in water:

a. By weighing in air and water.—

$$\text{Sp. gr.} = \frac{\text{(weight in air)}}{\text{(loss of weight in water)}}$$

b. By Nicholson's hydrometer. Let w_1 be the weight required to sink the instrument to the mark on the stem; to take the specific gravity of any solid substance, place a portion of it weighing less than w_1 in the upper pan, with such additional weight, say w_3, as will cause the instrument to sink to the zero mark. The weight of the substance is then w_1—w_3. Next transfer the substance to the lower pan, and again adjust with weight w_4 to the zero mark.

$$\text{Sp. gr.} = \frac{w_1 - w_3}{w_4 - w_3}$$

c. By the specific gravity bottle (applicable to powders). Weigh the flask filled to the mark with water, then place the substance, of known weight, in the flask, fill to the mark with water, and weigh again.

$$\text{Sp. gr.} = \frac{\text{weight of substance in air}}{\text{wt. in air} + \text{wt. of flask and water} - \text{wt. of flask filled with substance and water.}}$$

(2) Solids lighter than and insoluble in water. The solid is weighed by a piece of lead and weighed in water.

$$\text{Sp. gr.} = \frac{\text{(weight of substance in air)}}{\text{(wt. of lead in water)} - \text{(wt. of lead and substance in water)} + \text{(wt. of substance in air)}}$$

(3) Solids heavier than and soluble in water. Proceed as in 1 *a*, using instead of water some liquid without action on the solid.

(weight of bulk of liquid equal to substance) = (weight of substance in air) — (weight of substance in liquid).

$$\text{(wt. of bulk of water equal to substance)} = \frac{\text{(wt. of bulk of liquid equal to substance)}}{\text{(sp. gr. of liquid)}}$$

$$\text{Sp. gr.} = \frac{\text{(weight of substance in air)}}{\text{(weight of bulk of water equal to substance)}}$$

Liquids: (1) By the hydrometer.

(2) By the specific gravity bottle.

Weigh the bottle filled to the mark with water, and again when filled to the mark with liquid.

$$\text{Sp. gr.} = \frac{\text{(weight of liquid and bottle)} - \text{(weight of bottle)}}{\text{(weight of water and bottle)} - \text{(weight of bottle)}}$$

Tables of Specific Gravity will be found under Weights and Measures.

THERMOMETER SCALES.

Much annoyance is caused by the great difference of thermometer scales in use in the different civilized countries. The scale of Reaumur prevails in Germany. As is well known, he divides the space between the freezing and boiling points into 80 deg. France uses that of Celsius, who graduated his scale on the decimal system. The most peculiar scale of all, however, is that of Fahrenheit, a renowned German physicist, who in 1714 or 1715, composed his scale, having ascertained that water can be cooled under the freezing point, without congealing. He therefore did not take the congealing point of water, but composed a mixture of equal parts of snow and sal ammoniac, about —14 deg. R. The conversion of any one of these scales to another is very simple, and easily made. To change a temperature as given by Fahrenheit's scale into the same as given by the centigrade scale subtract 32 deg. from Fahrenheit's degrees, and multiply the remainder by 5-9. The product will be the temperature in centigrade degrees.

To change from Fahrenheit's to Reaumur's scale, subtract 32 deg. from Fahrenheit's degrees, and multiply the remainder by 4-9. The product will be the temperature in Reaumur's degrees.

COMPARATIVE SCALES OF THERMOMETER.

C.	R.	F.	C.	R.	F.	C.	R.	F.
−30	−24.0	−22.0	14	11.2	57.2	58	46.4	136.4
−29	−23.2	−20.2	15	12.0	59.0	59	47.2	138.2
−28	−22.4	−18.4	16	12.8	60.8	60	48.0	140.0
−27	−21.6	−16.6	17	13.6	62.6	61	48.8	141.8
−26	−20.8	−14.8	18	14.4	64.4	62	49.6	143.6
−25	−20.0	−13.0	19	15.2	66.2	63	50.4	145.4
−24	−19.2	−11.2	20	16.0	68.0	64	51.2	147.2
−23	−18.4	−9.4	21	16.8	69.8	65	52.0	149.0
−22	−17.6	−7.6	22	17.6	71.6	66	52.8	150.8
−21	−16.8	−5.8	23	18.4	73.4	67	53.6	152.6
−20	−16.0	−4.0	24	19.2	75.2	68	54.4	154.4
−19	−15.2	−2.2	25	20.0	77.0	69	55.2	156.2
−18	−14.4	−0.4	26	20.8	78.8	70	56.0	158.0
−17	−13.6	1.4	27	21.6	80.6	71	56.8	159.8
−16	−12.8	3.2	28	22.4	82.4	72	57.6	161.6
−15	−12.0	5.0	29	23.2	84.2	73	58.4	163.4
−14	−11.2	6.8	30	24.0	86.0	74	59.2	165.2
−13	−10.4	8.6	31	24.8	87.8	75	60.0	167.0
−12	−9.6	10.4	32	25.6	89.6	76	60.8	168.8
−11	−8.8	12.2	33	26.4	91.4	77	61.6	170.6
−10	−8.0	14.0	34	27.2	93.2	78	62.4	172.4
−9	−7.2	15.8	35	28.0	95.0	79	63.2	174.2
−8	−6.4	17.6	36	28.8	96.8	80	64.0	176.0
−7	−5.6	19.4	37	29.6	98.6	81	64.8	177.8
−6	−4.8	21.2	38	30.4	100.4	82	65.6	179.6
−5	−4.0	23.0	39	31.2	102.2	83	66.4	181.4
−4	−3.2	24.8	40	32.0	104.0	84	67.2	183.2
−3	−2.4	26.6	41	32.8	105.8	85	68.0	185.0
−2	−1.6	28.4	42	33.6	107.6	86	68.8	186.8
−1	−0.8	30.2	43	34.4	109.4	87	69.6	188.6
0	0.0	32.0	44	35.2	111.2	88	70.4	190.4
1	0.8	33.8	45	36.0	113.0	89	71.2	192.2
2	1.6	35.6	46	36.8	114.8	90	72.0	194.0
3	2.4	37.4	47	37.6	116.6	91	72.8	195.8
4	3.2	39.2	48	38.4	118.4	92	73.6	197.6
5	4.0	41.0	49	39.2	120.2	93	74.4	199.4
6	4.8	42.8	50	40.0	122.0	94	75.2	201.2
7	5.6	44.6	51	40.8	123.8	95	76.0	203.0
8	6.4	46.4	52	41.6	125.6	96	76.8	204.8
9	7.2	48.2	53	42.4	127.4	97	77.6	206.6
10	8.0	50.0	54	43.2	129.2	98	78.4	208.4
11	8.8	51.8	55	44.0	131.5	99	79.2	210.2
12	9.6	53.6	56	44.8	132.8	100	80.0	212.0
13	10.4	55.4	57	45.6	134.6			

To change the temperature as given by the centigrade scale into the same as given by Fahrenheit, multiply the centigrade degrees by 9-5 and add 32 deg. to the product. The sum will be the temperature by Fahrenheit's scale.

To change from Reaumur's to Fahrenheit's scale, multiply the degrees on Reaumur's scale by 9-4 and add 32 deg. to the product. The sum will be the temperature by Fahrenheit's scale.

For those who wish to save themselves the trouble we have calculated the preceding comparative table.

VALUE OF RARE ELEMENTS.

Elements.	Quantity.	Value.
Boron nitrate (New York)	lb.	$1.50
Boron, pure crystals (Germany)	10 grams	13.09
Boron, amorphous, pure (Germany)	kilo.	119.00
Boron, powder (*Moissan*) (Germany)	"	142.80
Cæsium nitrate crystals (Germany)	100 grams	11.90
Cæsium oxide hydrated (Germany)	"	13.09
Calcium metal, (Germany)	1 gram	4.28
Cerium metal, fused (Germany)	"	2.02

VALUE OF RARE ELEMENTS.—*Continued.*

Elements.	Quantity.	Value.
Cerium metal, powder (Germany)	1 gram	$1.67
Cerium nitrate (New York)	lb.	10.00
Didymium metal, fused (Germany)	1 gram	5.47
Didymium metal powder (Germany)	"	4.71
Didymium nitrate (New York)	lb.	35.00
Erbium metal (Germany)	1 gram	3.09
Erbium nitrate (New York)	lb.	40.00
Germanium metal, fused (Germany)	1 gram	59.50
Germanium metal, powder (Germany)	"	57.12
Glucinum metal, crystals (Germany)	"	9.04
Glucinum metal, fused in balls (Germany)	"	35.70
Glucinum metal, powder (Germany)	"	5.95
Glucinum nitrate (New York)	lb.	20.00
Iridium metal, fused (Germany)	10 grams	10.71
Iridium metal, powder (Germany	"	9.52
Lanthanum metal, powder (Germany)	1 gram	4.28
Lanthanum metal, in balls (Germany)	"	9.04
Lanthanum nitrate (New York)	lb.	30.00
Lithium metal, pure (Germany)	1 gram	0.71
Lithium metal, chem. pure (Germany)	"	2.38
Lithium carbonate (New York)	lb.	1.50
Lithium nitrate (New York)	oz.	.60
Magnalium metal, ingot (Germany)	kilo.	3.57
Magnalium metal, sheet (Germany)	"	7.14
Magnesium metal, ingot (Germany)	"	4.28
Magnesium metal, ribbon, wire, sheet (Germany)	"	7.62
Magnesium metal, sticks (Germany)	"	5.47
Magnesium metal, cubes (Germany)	"	5.00
Magnesium metal, powder (Germany)	"	3.81 @ 5.00
Manganese metal, pure fused (Germany)	"	3.81
Manganese metal, com'l (94 @ 97%) (Germany)	"	1.25
Molybdenum metal, pure (Germany)	"	17.85
Molybdenum metal, com'l, fused (Germany)	"	6.66
Molybdenum metal, pure, fused (Germany)	100 grams	9.52
Molybdenum metal, powder (Germany)	kilo.	4.05
Niobium metal, pure (Germany)	1 gram	4.71
Osmium metal (Germany)	10 grams	17.14
Palladium metal (Germany)	"	8.57
Platinum (New York)	oz.	18.50
Polonium	——	Speculative.*
Potassium metal in balls (Germany)	kilo.	16.60
Radium	See Radi	um, p. 449†
Rhodium metal (Germany)	10 grams	26.18
Rubidium metal pure (Germany)	1 gram	4.76
Ruthenium metal, powder (Germany)	"	2.38
Ruthenium metal, sponge (Germany)	"	4.28
Selenium metal (Germany)	kilo.	16.66
Silicium metal, com'l, fused (Germany)	"	9.52
Sodium metal (New York)	lb.	0.50
Strontium metal (Germany)	1 gram	6.19
Strontium nitrate (New York)	lb.	0.08
Tantalum metal, pure (Germany)	1 gram.	3.57
Tellurium metal, chem. pure sticks (Germany)	kilo.	106.10
Tellurium metal, chem. pure powder (Germany)	"	107.10
Thallium metal (Germany)	"	23.80
Thorium nitrate (New York)	lb.	4.50
Titanium metal, pure (Germany)	kilo.	23.80
Uranium metal (Germany)	"	190.40
Uranium nitrate (New York)	oz.	0.25
Wolfram metal, powder for steel makes (Germany)	kilo.	1.79
Yttrium metal (Germany)	1 gram	3.33
Zirconium metal (Germany)	kilo.	95.20
Zirconium nitrate (New York)	lb.	8.00

* The value of polonium is purely speculative. Minute quantities have been sold at very high prices. It is worth 75 cents a gram on bismuth and platinum plates. The quantity of polonium is of course very minute.

† The supply is so small that any price can be asked. $3,500,000 is the current "newspaper" estimate per pound. See Radium, page 449.

[Table furnished by the *Engineering and Mining Journal.*]

RADIUM AND RADIO-ACTIVITY.

The marvels of radium may be said to have been more or less foreshadowed by the discovery of the Roentgen rays. It was immediately determined that the emanations of a Crookes tube were not ethereal undulations such as ordinary light, but that they consisted of actual material particles of matter highly charged with electricity. Naturally the attempt was made to discover whether the phenomena of phosphorescent substances were not akin to those of the Crookes tube. The leading spirit in this movement was Professor Henri Becquerel, who selected the metal uranium as the subject of his experiments. He accidentally discovered that the so-called phosphorescent attributes of uranium were not due to the absorption of sunlight, but that the substance was spontaneously active, and that the light which came from radium was a new kind of emanation entirely different from the X-rays. To these new radiations the name "Becquerel Rays" was given.

Uranium is obtained from pitchblende, an ore more or less widely distributed about the world, but found chiefly in Bohemia and in Cornwall. Madame Curié, who, at the time Becquerel was making his investigations, was a senior student at the Municipal School of Physics and Technical Chemistry in Paris, had selected "Radio-Activity"—a name which she coined—as the subject of her Doctor's thesis. Naturally it was necessary for her to study uranium and similar minerals with some care. She found that, after having extracted all the uranium contained in her specimen of pitchblende, there still remained in the residue a substance far more active than uranium. After isolating this unknown radiant substance and analyzing it, she found that it contained two new elements. The one she christened "polonium," after Poland, the land of her birth; the other she named "radium."

Several tons of pitchblende must be treated and concentrated before a few grains of radium are obtained. But those few grains are worth more than any precious gem or metal in the world. Indeed they have almost any value which their fortunate possessor may choose to give them. There are probably not two pounds of pure radium in existence; but at the present market price they would be worth each about three and one-half million dollars. There is more gold in sea water than radium in pitchblende; and that is why its price is so high.

The properties of radium will probably necessitate a decided revision in some time-honored chemical theories; for radium refuses to conform to our long-established atomic theories, and behaves in a most inexplicable fashion. In the first place the radio-activity of the element has been found to consist of three distinct sets of emanations, which have been respectively christened the Alpha, the Beta, and the Gamma rays, for want of better names.

The Alpha rays are not, like ordinary light, ethereal pulsations, but actual material particles hurled off at a speed of about 20,000 miles per second from the parent mass. They are highly charged with positive electricity. Their speed is about 40,000 times greater than that of a rifle bullet.

The Beta rays, which consist of particles of matter, corpuscles of electricity or "electrons" as the modern physicist calls them, move still more swiftly. Each of the Beta particles (very much smaller in size than the Alpha particles) travels at the rate of about 100,000 miles a second. They are the fastest moving objects known in the universe; for their speed is three hundred times faster than that of the swiftest star. Such is their velocity that it takes a foot of solid iron to stop them.

The Gamma rays are probably Roentgen rays, if one may judge by the similarity of the properties of the two. Like the Beta rays, the Gamma emanations have remarkable penetrating properties. But of the three kinds of rays discharged by radium, the Gamma rays are the most difficult to detect and the least perfectly understood.

Professor Curié, Madame Curié's husband, has discovered that radium constantly maintains a temperature of about five or six degrees above the surrounding atmosphere. For some time this startling phenomenon baffled physicists. Here was a substance constantly giving off heat without being apparently consumed, and without anything to make it hot. It is now thought that this strange property can be explained by assuming that the particles collide with one another, and that the heat generated by the impact (a heat that must be very marked when it is considered how enormous

is the energy of a particle moving at the rate of many thousand miles a second) is sufficient to explain the heat generated by radium.

The fact that radium is a spontaneous source of thermal energy is in itself a fact sufficiently startling. Sir William Ramsay, however, has discovered still other startling properties of this startling substance. He collected the material particles which are shot from the substance, analyzed them, and found that after a few days they changed into helium, a gas which was first discovered burning in the sun. This seems dangerously like the transmutation of one element into another, the problem on the solution of which the medieval alchemist had worked for centuries. After ages of labor seventy-odd bits of primordial matter had been wrung from the earth, so simple and so unchangeable in their nature that they were deemed elements. And now one of them proves to be nothing but the product of another. Can we ever be certain again that the rest are not also likely to change? Is it any wonder that our chemistry needs revision?

The atomic weight of radium has been ascertained by Madame Curié to be 225; that of helium is 2.2. In other words, every atom of radium breaks up into about 100 parts of helium. What becomes of the old teaching that atoms are indivisible particles of matter? Some of the more advanced thinkers have abandoned the atom and adopted the "electron" as the ultimate unit. The atom is certainly quite inadequate to account for the properties of radium. Atoms may be said to be composed of electrons moving, like miniature solar systems, with inconceivable rapidity in well-defined orbits. Sometimes a little planet of that system becomes unstable, darts off with terrific speed like a comet, and thus gives rise to the phenomena of radium, of uranium, and of every other radioactive substance.

Has radium any practical value? it may be asked. So far it is more of a scientific curiosity than anything else. Still, it is not without some use. It is an excellent detector of false diamonds; for it causes the real gem to glow with wonderful brilliancy, while the paste imitation is left comparatively lusterless. Then, again, radium kills bacteria and even very small animals. The modern physician has used the substance with some success in treating certain diseases, among them cancer and lupus. Living tissues of the body are strangely affected by short exposures to the substance. Sores are produced, like burns, which heal only after weeks have elapsed. An electroscope has also been invented, the underlying principle of which is dependent upon the properties of radium.

PRICES OF FRENCH RADIUM, JULY, 1904.

Form.	Activity.	Price per Gramme.	Price per Ounce.	Price per Milligram.
		Dollars	Dollars	Dollars
Radium chloride or bromide	50	4	125	.004
	100	8	250	.008
	500	30	910	.040
	1,000	60	1,820	.080
	5,000	240	7,280	.40
	10,000	500	15,050	.80
	20,000	1,000	30,100	1.60
	50,000	2,000	60,200	4.00
	100,000	4,000	120,400	8.00
	500,000	20,000	602,000	40.00
Radium, pure	1,800,000	80,000	2,408,000	144.00

—Table furnished by Dr. George F. Kunz.

MELTING POINTS OF CHEMICAL ELEMENTS.

The melting points of chemical elements are, in many cases, somewhat uncertain, owing to the different results obtained by different observers. This table gives the probable average value.

Substance.	Melting Point, Degrees C.	Substance.	Melting Point Degrees C.
Aluminum	625	Magnesium	775
Antimony	435	Manganese	1900
Bismuth	268.1	Mercury	−39.04
Bromine	−7.27	Nickel	1500
Cadmium	318	Osmium	2500
Cæsium	26.5	Nitrogen	−208
Chlorine, liquid	−102	Palladium	1600
Cobalt	1650	Phosphorus	44.25
Copper	1100	Platinum	1900
Gallium	30.15	Potassium	60
Germanium	900	Rhodium	2000
Gold	1080	Rubidium	38.5
Indium	176	Ruthenium	1800
Iodine	112	Selenium	217
Iridium	2225	Silver	950
Iron, pure	1635	Sodium	97.6
" white pig	1075	Sulphur	115.1
" gray pig	1200	Tellurium	470
Steel	1360	Thallium	289
" cast	1375	Tin	230
Lead	326	Zinc	415
Lithium	180		

BOILING POINTS OF CHEMICAL ELEMENTS.

Substance.	Boiling Point, Degrees C.	Substance.	Boiling Point Degrees C.
Antimony	1535	Oxygen	−183
Arsenic	449	Ozone	−106
Bismuth	1413	Phosphorus	288
Bromine	62.08	Potassium	695
Cadmium	779	Selenium	675
Chlorine	−33.6	Sodium	825
Iodine	over 200	Sulphur	448.1
Lead	about 1,525	Thallium	1700
Magnesium	1100	Tin	about 1,550
Mercury	357	Zinc	958
Nitrogen	−194.4		

HEAT OF COMBUSTION.

Heat of combustion of some common organic compounds.
Products of combustion, CO_2 or SO_2 and water, which is assumed to be in a state of vapor.

Substance.	Therms per Gramme of Substance.	Substance.	Therms per Gramme of Substance.
Acetylene	11,923	Gas:	
Alcohols:		Methane	13,063
Amyl	8,958	Naphthalene	9,618–9,793
Ethyl	7,183	Gunpowder	720–750
Methyl	5,307	Oils:	
Benzene	9,977	Lard	9,200–9,400
Coals:		Olive	9,328–9,442
Bituminous	7,400–8,500	Petroleum, American crude	11,094
Anthracite	7,800	" " refined	11,045
Lignite	6,900	" Russian	10,800
Coke	7,000	Woods:	
Carbon disulphide	3,244	Beech with 12.9 per cent. H_2O	4,168
Dynamite, 75 per cent	1,290	Birch " 11.83 " " "	4,207
Gas:		Oak " 13.3 " " "	3,990
Coal gas	5,800–11,000	Pine " 12.17 " " "	4,422
Illuminating	5,200–5,500		

SIZES OF DRY PLATES.

3¼×4¼ inches	8×10 inches
4 ×5 "	10×12 "
4¼×5½ "	11×14 "
4½×6½ "	14×17 "
4¾×6½ "	16×20 "
5 ×7 "	17×20 "
5 ×8 "	18×22 "
6½×8½ "	20×24 "

SIZES IN FRANCE AND GERMANY.

6½× 9 cm	2.5× 3.6 inches
9 ×12 "	3.6× 4.7 "
12 ×15 "	4.7× 5.9 "
13 ×18 "	5.1× 7.0 "
12 ×20 "	4.7× 7.8 "
15 ×21 "	5 9× 8.2 "
15 ×22 "	5.9× 8.6 "
18 ×24 "	7.0× 9.4 "
21 ×29 "	8.2×10.6 "
24 ×30 "	9.4×11.8 "
27 ×33 "	10.6×12.9 "
27 ×35 "	10.6×13.7 "
30 ×40 "	11.8×15.7 "
40 ×50 "	15.7×19.6 "
50 ×60 "	19.6×23.6 "

SIZES IN ITALY.

9×12 cm	3.6× 4.7 inches
12×16 "	4.7× 6.3 "
12×18 "	4.7× 7.0 "
13×18 "	5.1× 7.0 "
12×20 "	4.7× 7.8 "
18×24 "	7.0× 9.4 "
21×29 "	8.2×10.6 "
24×30 "	9.4×11.8 "
27×33 "	10.6×12.9 "
30×36 "	11.8×14.1 "
40×50 "	15.7×19.6 "
50×60 "	19.6×23.6 "

AIR.—The following data are useful in calculations relating to air:

1. To find the quantity of nitrogen by volume corresponding to 1 volume of oxygen, multiply by 3.770992.

2. To find the quantity of oxygen by volume corresponding to 1 volume of nitrogen, multiply by 0.265182.

3. To find the quantity of nitrogen by weight corresponding to 1 part by weight of oxygen, multiply by 3.313022.

4. To find the quantity of oxygen by weight corresponding to 1 part by weight of nitrogen, multiply by 0.301839.

5. To find the quantity of nitrogen by volume corresponding to 1 part by weight of oxygen, multiply by 2.6365411.

6. To find the quantity of oxygen by volume corresponding to 1 part by weight of nitrogen, multiply by 0.2730071.

7. To find the quantity of nitrogen by weight corresponding to 1 part by volume of oxygen, multiply by 3.6629154.

8. To find the quantity of oxygen by weight corresponding to 1 part by volume of nitrogen, multiply by 0.3792848.

TO TEST AIR FOR SEWER GAS. — Saturate unglazed paper with a solution of 1 oz. of pure lead acetate in half a pint of rain water; let it partially dry, then expose in the room suspected of containing sewer gas. The presence of the latter in any considerable quantity soon darkens or blackens the test paper.

CHAPTER II.

ASTRONOMY.

THE TELESCOPE.—Telescopes are of two kinds, namely, *refracting* and *reflecting* telescopes. The refracting telescope consists of an object-glass which forms an image of the object, and an eye-glass by which the image is viewed. The reflecting telescope consists of a *concave mirror* which receives light from the distant object, and reflects it so that the rays converge to a focus and form an image, the image being viewed by an eye-glass. The terrestrial telescope consists of two telescopes like the preceding—which are called astronomical telescopes, and give an inverted image—the second inverting the inverted image of the first, and so giving an upright image. Eye-pieces generally have two lenses, and have names according to the position of the focus. Ramsden's eye-piece has two lenses, the focus being just beyond the field lens. It is called a *positive* eye-piece, and it can be used as a magnifying glass. Huyghens' eye-piece also has two lenses, the focus being between the two. It is called a *negative* eye-piece, and cannot be used as a magnifying glass. These compound eye-pieces enable us to get rid of *spherical* and *chromatic* aberration. The achromatic object-glass is made by joining together two lenses, one of flint glass and the other of crown glass. The dispersion is made equal and opposite, but the bending powers are unequal. A lens is equivalent to a number of prisms placed base to base, the outer prisms having a greater angle to cause the rays to bend more, so that all the rays may come to one point, called the focus. The magnifying power of a telescope is found by dividing the focal length of the object-glass by the focal length of the eye-piece.

THE EQUATORIAL TELESCOPE.—The *equatorial* is an ordinary telescope, mounted in such a way that it can easily be directed to any part of the heavens. The *polar* axis is parallel to the earth's axis, that is to say, it is inclined at an angle equal to the latitude of the place, at Washington about 39°, at London about 51½°. The telescope can be moved round the polar axis in a plane which is parallel to the earth's equator, and this motion is said to be motion in *right ascension*. The telescope can also be moved up and down in a plane at right angles to the earth's equator, and this motion is called motion in *declination*. Whatever part of the skies an object is in, the equatorial can be directed to it, and the object can be kept constantly in view, because there is a kind of clock which drives the instrument round at the same speed at which the earth is turning round.

THE TRANSIT INSTRUMENT.—The transit instrument is a telescope mounted on a horizontal axis, so as to be capable of moving in the meridian only. It is used to determine the exact moment at which celestial bodies cross the *meridian*, that is, when they are in a true north or south position. It is also used for determining the *declination* of celestial objects, that is, how far in angular measures these bodies are from the celestial equator.

THE SIDEREAL CLOCK.—The sidereal clock is similar to an ordinary clock, but it is regulated to keep accurate time with the apparent diurnal movements of the stars, instead of with the mean sun. It shows the same time as clocks and watches only once in a year, namely, at the Vernal Equinox, about the 21st of March. It gains about four minutes each day on the ordinary clock, and in a year it gains a whole day, so that there are 366 sidereal days and only 365 solar days in one year. The sidereal noon occurs when the first point of Aries passes the meridian, and the hours are reckoned from 0 to 24. The time by the sidereal clock at which a celestial body crosses the meridian is equal to the right ascension of that particular object. Conversely, if the exact right ascension of a star be known, the error of the clock can be determined by observing a transit of the star.

THE CHRONOGRAPH.—The chronograph consists of a cylinder covered with paper, and made to rotate uniformly by clockwork. It is connected electrically with the sidereal clock, which, as it ticks, makes dots on the paper at equal distances by means of a recording pen, and these dots represent seconds. Fractions of a second are recorded by the observer touching a key, which causes a second pen to make a dot on the cylinder as it turns round. This dot would come between two second dots, and the distance is measured from these. In this manner the $\frac{1}{100}$ or $\frac{1}{1000}$ of a second can be estimated. The small fractions of a second obtained by the chronograph are necessary in fixing the right ascension and declination by the transit instrument.

THE MICROMETER.—The micrometer is used for measuring small *arcs*. It consists of two *wires*, which can be brought together or separated at pleasure by means of a screw. An equatorial star appears to move through about 15° in one hour, 1° in four minutes, 15′ in one minute, or 15″ of arc in one second of time. The distance that the wire moves for one turn of the screw is found by allowing a star to pass from one wire to

the other, and then allowing 15″ of arc for every second of time taken in so doing. The diameter of the moon, the sun, or a planet can be estimated in angular measure by the micrometer, and then, knowing the distance of these objects, their size can be calculated from a knowledge of the relation that exists between the radius of a circle and its circumference.

THE THEODOLITE.—The theodolite is used for measuring horizontal and vertical angles, that is, altitude and azimuth. It consists of a small telescope, which can be moved up and down, and the inclination is shown by a graduated circle, called the altitude circle. The telescope can also be twisted around a vertical axis, and the angular distances of objects from the north point of the horizon measured, that is, *azimuth*.

THE SEXTANT.—The sextant is chiefly employed on board ship for observing the altitude of the sun, lunar distances, etc., in the determination of latitude and longitude. It consists of a telescope, through which the observer looks. Opposite to the telescope is a mirror, half silvered and half plain, so that he can see directly through the plain part to an object, and he can bring a second object to coincide with the first by means of a second mirror attached to the movable arm, which reflects its light on to the silvered part of the first mirror, and from thence through the telescope. The reading on the sextant then gives the angular distance between the two objects.

VERNIERS.—Verniers are divided scales, with their divisions a little smaller than those on the main scale to which they are attached. If a length equal to nine divisions of the main scale be divided into ten parts, then each of these latter will be $\frac{1}{10}$ less than the former. In general, n divisions of the vernier are equal to $n - 1$ divisions of the scale, which enables us to read to the nth part of a division, whatever that may be. If the divisions on the main scale were tenths of an inch we could get hundredths by dividing a length equal to nine of them into ten parts, then the difference between the lengths of these would be $\frac{1}{10}$ of $\frac{1}{10}$ of an inch, that is, $\frac{1}{100}$.

ANGULAR MEASUREMENT.—The measurement of the distances of the sun, moon, and planets depends upon our knowledge of the properties of triangles. Our knowledge of the size of the earth and other bodies in space depends upon angular measurement. Our knowledge of the mass, volume, and density of the sun, moon, and planets, and even the masses and distances of some of the stars, depends upon our ability to measure angles.

MEASUREMENT OF TIME.—An ancient method of measuring time was by the *gnomon*, an upright stick in the ground which cast a shadow of the sun, the length and position of which varied according to the time of day, hence the sun-dial. Other methods consisted in chanting psalms, burning candles, and dropping water or sand from one vessel to another, hence *clepsydra* and *hour-glass*, etc. Clocks came into use in England in the fourteenth century; but instead of a pendulum a vibrating horizontal bar was employed—DeWyck's clock. Galileo discovered the pendulum, which suggested itself to him by observing a swinging lamp in the Cathedral of Pisa. Huyghens found that the vibrations of a pendulum were not equal for any length of swing; hence the introduction of the *cycloidal* pendulum. Hooke's anchor escapement was the next advance, which allowed of a smaller arc of swing and eliminated a certain amount of friction, but it is not used in the best clocks because of the *recoil*. Graham overcame the recoil just mentioned by using pallets whose surfaces were arcs of circles, hence *dead-beat escapement*. The chronometer escapement has a balance-wheel in place of a pendulum, which thus admits of a more compact arrangement than is possible in a clock with a pendulum; moreover, it will work in any position.

ALTITUDE AND AZIMUTH.—The altitude of a celestial object, as a star, is its angular height above the horizon, and its complement—or that which is required to make it equal to a right angle—is called the *zenith distance*. The azimuth of a celestial object is its angular distance from the north point of the horizon. It is found by drawing an imaginary arc from the zenith point through the object till it cuts the horizon, and then measuring the angular distance between this point and the north point.

THE SPHERE OF OBSERVATION.—The appearance of the starry sphere presents different aspects, depending upon the locality of the observer. At Washington the north pole is elevated about 39° above the horizon, at London about 51½° above the horizon; this elevation of the pole always being equal to the latitude of the place of observation. The celestial equator being 90° distant from the pole, will cut the horizon of London at an angle of 38½°, and that of Washington at about 51°, the northern side in each case being depressed below, and the southern side elevated above, the horizon.

PARALLAX.—The moon's place, when looked at through a telescope from London and some distant place, as Cape Town, seems to change—that is, the telescopes contain an angle. This contained angle is less when the sun is viewed in the same way, but when stars are looked at similarly the angle disappears altogether—that is, stars have no parallax, while the sun, moon, and planets have parallax, or angular displacement caused by change of position.

ROTUNDITY OF THE EARTH.—The concave heavens; the disappearance of a ship at sea; the extension of the horizon as we ascend high elevations; the frequent circumnavigation of the globe; the earth's shadow cast by the sun upon the moon during an eclipse; the spherical form of the sun, moon, and planets—all confirm our belief that the earth is globular in form.

MAGNITUDE OF THE EARTH.—The size of the earth is found by observing a star in the exact zenith of any place, then traveling along a direct north line, till the star has declined 1° from the zenith, and measuring the distance traversed. This distance would be the length of 1° in miles, and 360 times that length would give the circumference of the earth.

DEMONSTRATION OF EARTH'S ROTATION.—A heavy body set in motion tends to retain its original plane of motion. Foucault's pendulum consists of a heavy ball at the

end of a long wire, supported by a steel pivot on an agate plane. The ball, when set swinging, seems to change its direction of swing across a graduated circle on a table beneath it, but, as we know that the pendulum tends to keep to the same plane of motion, and that there is so little to prevent it from doing so, we conclude it is the earth which is turning on its axis and carrying the table with it. The gyroscope is essentially the same as the pendulum, a heavy rotating disk taking the place of the swinging bob of the pendulum. The rotating disk is supported inside a horizontal ring, this ring being in its turn supported by knife edges resting on steel plates in the circumference of a vertical ring, and this vertical ring is supported by a torsionless thread, so that all the parts are nicely counterpoised and are free to move. A pointer attached to the vertical ring is found to move over a graduated scale at the same rate as the pendulum changed its plane of motion; hence, we conclude that it is the earth which moves, because we know that the rotating disc holds to its initial plane of motion. The rotation of the earth on its axis furnishes us with an invaluable *unit of time.*

REVOLUTION OF THE EARTH IN ITS ORBIT. —The stars which are seen nearest to the sun after sunset at different times of the year are not the same, but belong to different signs of the zodiac. This change of position of the sun with respect to the stars takes place at the rate of about 1° a day, so that the whole heavens appear to revolve once in a year independent of their diurnal revolution. This is due to the real revolution of the earth in its orbit. The stars appear to describe little ellipses in the course of a year, but, as a matter of fact, it is the light coming from the stars that is displaced by the motion of the earth in its orbit, the form of this orbit being elliptical, so that the star's position is changed in such a way as to project an ellipse similar to that which the earth traces out. This phenomenon is known as the *aberration of light,* and was discovered by Bradley.

VELOCITY OF LIGHT.—Fizeau determined the velocity of light by reflecting a spot of light from a mirror at one station to a second mirror at a distant station. The light was brought to a focus at the required points by means of lenses. A toothed wheel whose revolutions could be registered was so placed that its teeth revolved in the focus, and the spot of light could be seen between two teeth. It was possible to turn the wheel so quickly that the spot of light was stopped by a tooth coming up before it could pass through. The distance between the stations being known, and the rate at which the wheel turned, the velocity of light could be found. Foucault's method consisted of a rapidly rotating mirror, on which a beam of light was admitted through a slit. It was then reflected on to a lens, after which it was brought to a focus on a concave mirror at some distance. It was found possible to turn the mirror so quickly that it moved through a small angle before the spot of light returned. The distance between the mirrors, the rate of rotation of the mirror, and the amount of displacement being known, the velocity of light could be estimated. The velocity of light and the aberration angle being known the sun's distance can be found.

(1) The ratio of the velocity of light and the earth in its orbit as determined by observation is as 10,089 : 1.

(2) The earth completes its orbit in 365¼ days.

(3) Light would do the same journey in $\frac{365\frac{1}{4}}{10,089}$ days.

(4) Knowing the time it would take to complete the revolution we can find how long it would take to cross the diameter, and therefore the radius.

(5) We multiply the number of seconds taken by light to cross the radius of the earth's orbit by the velocity of light, and it gives us 92,628,000 miles as the sun's distance.

THE SUN NOT ALWAYS AT THE SAME DISTANCE FROM THE EARTH.—In the *Nautical Almanac* the sun's apparent diameter is given for every day in the year. The apparent diameter was 32′35.2″ on January 3rd, 1904, and on July 4th of the same year it was only 31′30.7″. This proves the sun is farther away from us in summer than in winter.

PERIHELION AND APHELION.—When the earth is nearest to the sun it is said to be in *Perihelion,* and when farthest from the sun it is said to be in *Aphelion.*

THE EARTH MOVES WITH VARYING VELOCITY IN ITS ORBIT.—This is ascertained by measuring the sun's longitude for two successive days at different times of the year, by which means it is found in December to move over 61′10.0″ within a period of twenty-four hours, while in June it only moves over 57′10.8″ in the same time.

KEPLER'S LAW OF EQUAL AREAS.—Kepler found that the line joining the center of the sun with the center of the earth moved over equal areas in equal times, that is, the greater distance of the earth from the sun in June compensated for the smaller arc of motion in longitude, so that lines drawn from the sun to the extremities of the arcs moved over make equal triangles.

HOW THE INCLINATION OF THE ECLIPTIC TO THE PLANE OF THE EARTH'S EQUATOR IS DETERMINED.—The elevation of the sun above the horizon is measured by the shadow cast by the gnomon, or the north polar distance is ascertained by the transit instrument for each day in the year. In either case the sun will be found to oscillate backwards and forwards over an arc of about 47°, half of which arc is the inclination of the ecliptic to the equator.

NODES.—The two points where the plane of the ecliptic crosses the plane of the celestial equator or equinoctial are called *nodes,* that point at which the sun appears to come up from below the equator being called the *ascending node,* and that at which the sun appears to descend from above the same plane being called the *descending node.*

THE FIRST POINT OF ARIES.—The *ascending node* above referred to is the *first point of Aries.* It is universally used by astronomers for fixing the longitudinal and right ascension of celestial bodies.

THE SIDEREAL, SOLAR, AND MEAN SOLAR DAY.—The sidereal day is the interval which elapses between two successive appearances of the same star on the meridian. The solar

day is the interval which elapses between two successive appearances of the sun on the meridian, but these are not of the same length. The mean solar day is the interval of time obtained by adding all the solar days in a year together, and then dividing by the number of days in a year.

EQUATION OF TIME.—The inequality of the solar days arises from two causes, namely, the *obliquity of the ecliptic to the equator*, and the *unequal velocity of the earth in its orbit*. The *equation of time* is the *algebraic sum* of these two variables—that is to say, sometimes they both cause the sun to come too soon to the meridian; at other times one causes the sun to come up too soon and the other too late. In the former case the sum of the two corrections, and in the latter case the difference of the two corrections, is the equation of time, and so on.

THE SEASONS.—The seasons are the result of the revolution of the earth in its orbit and the inclination of the ecliptic to the equator. The sun on this account attains different heights above the horizon, giving different lengths of day and night. By reason of its giving to the earth more heat in the day than it loses by radiation in the night, and *vice versa*, we have summer or winter as the case may be.

THE YEAR.—The ordinary or *tropical* year is the period which elapses between two successive appearances of the sun at the vernal equinox. The *anomalistic* year is the period which elapses between two successive returns of the sun to his *perigean* point. The *sidereal* year is the time which elapses between two successive appearances of the same star on the meridian at the same time of day.

PRECESSION AND NUTATION.—The sun and moon attract the protuberant portion of the earth's equator more on that side nearest to them than on that side farthest away, and in this way the differential attraction tends to tilt the axis a little, so that it describes a circle in about 25,800 years. The moon's differential attraction is greater than that of the sun. On account of the moon continually changing its relation to the earth's equator, it causes the axis of the earth to describe a circle with a wavy circumference, to which effect the term *nutation*, or nodding of the earth's axis, is applied.

ASTRONOMICAL SYMBOLS AND ABBREVIATIONS.

☉	The Sun.	°	Degrees.
☾	The Moon.	′	Minutes of Arc.
☿	Mercury.	″	Seconds of Arc.
♀	Venus.	N. North.	S. South.
⊕ or ♁	The Earth.	E. East.	W. West.
♂	Mars.		°
♃	Jupiter.	0. ♈ Aries.	0
♄	Saturn.	I. ♉ Taurus.	30
♅	Uranus.	II. ♊ Gemini.	60
♆	Neptune.	III. ♋ Cancer.	90
☌	Conjunction.	IV. ♌ Leo.	120
□	Quadrature.	V. ♍ Virgo.	150
☍	Opposition.	VI. ♎ Libra.	180
☊	Ascending Node.	VII. ♏ Scorpio. . . .	210
		VIII. ♐ Sagittarius	240
☋	Descending Node.	IX. ♑ Capricornus	270
		X. ♒ Aquarius. . .	300
h	Hours.	XI. ♓ Pisces.	330
m	Minutes of Time.		
s	Seconds of Time.		

LATITUDE, LONGITUDE, RIGHT ASCENSION, AND DECLINATION.—Terrestrial latitude is measured from the equator to the poles, north and south. Terrestrial longitude is, in England, measured from the meridian of Greenwich, but other countries use their own meridians. Right ascension is measured from the first point of Aries. Declination is measured from the celestial equator. Celestial longitude is measured from the first point of Aries. Celestial latitude is measured from the ecliptic.

VARIATION IN THE LENGTH OF DEGREES OF LATITUDE.

Country.	Latitude.	Length of Degree in Feet.	Observer.
	° ′ ″		
Sweden. . .	N. 66 20 10	365,744	Maupertuis
Denmark. .	N. 54 8 13.7	365,087	Schumacher
England .	N. 52 35 45	364,971	Roy
India	N. 12 32 20.8	362,956	Lambton
Peru.	S. 1 31 0.4	362.790	Lacondamine
Cape of GoodHope	S. 33 18 30	364,713	Lacaille

MEASUREMENT OF THE SIZE OF THE SUN AND PLANETS.—The ratio between the radius of a circle and its circumference is always the same, no matter how large or small the circle may be. Thus, an arc of 57.2958° on any circle is equal in length to the radius of that circle; and if this be reduced to seconds of arc, we get 206,265″ as the number of seconds in a length of arc equal to radius. The mean angular diameter of the sun, as measured by the micrometer, is a little over 32′ of arc. We may consider the sun to form part of the circumference of a circle, with its distance from the earth as radius. There are 1920″ in 32′, and $\frac{206{,}265}{1920} = 108$ nearly; hence the distance of the earth from the sun is 108 times the diameter of the sun, whatever that may be. But we know the distance of the sun to be 92,885,000 miles; so that the diameter of the sun must be $\frac{92{,}885{,}000}{108} = 860{,}000$ miles. The same method applies to the planets and their satellites as well as to the sun. The angular diameter of the body being measured in seconds of arc, it bears the same ratio to 206,265 (the number of seconds in a length of arc equal to radius) that the diameter in miles bears to the distance in miles; or, calling the actual diameter d, and the real distance D, we have $d = \frac{D \times \text{angular diameter}}{206{,}265}$. For example—the moon, in round numbers, is 240,000 miles distant, and its angular diameter is a little over 31′; hence, by the formula, its diameter is—

$$d = \frac{240{,}000 \times 1860}{206{,}265} = 2164 \text{ miles.}$$

DENSITY OF THE EARTH.

Experiment.	Mean Density.	Observer.
Schehallien.	5.01	Maskelyne
Attraction of leaden ball	5.48	Cavendish
Ditto, repeated.	5.66	Baily
Harton coal-pit.	6.56	Airy
Probable value.	5.53	

To Find the Period of a Planet.—The synodic period may be readily observed, and from it the actual time occupied by a planet in completing its revolution round the sun can be calculated. For example, the synodic period of Mercury is 115.9 days; this means that the earth and the planet being in a line with the sun at any time, the latter has progressed in its orbit so quickly as to complete an entire revolution and again overtake the earth during the period of 115.9 days. Now the earth moves $\frac{360°}{365.25} = 0.9856°$ in a day, and in the entire period $115.9 \times 0.9856° = 114.2°$. But the planet has moved $360° + 114.2° = 474.2°$ in the same time, hence the period of the planet is to that of the earth as $114.2° : 474.2°$, that is, $\frac{114.2° \times 365.25}{474.2°} = 88$ days nearly.

Shooting Stars.—The names of the principal meteor swarms and the dates of their appearance are as follows:—

Name.	Date.	Comet having same Orbit.
Andromedes .	23 November	Biela's
Lyrids.	20 April.	Comet I. 1861
Leonids.	15 November	Tempel's, 1866
Perseids.	11 August. . .	Comet III. 1863

The number of stars in the northern hemisphere in Argelander's catalogue is 324,000. The number of known variables is 111, and the suspected variables 381. Roughly, then, there is one variable in every 660 of the known stars. According to Duner, about 1 in 7 of the third type stars is variable.

To Find the Time of Sunrise and Sunset by means of the Terrestrial Globe.—The time of sunrise or sunset may be found for any day by elevating the north or south pole equal to the sun's declination north or south for any given day. The place being under the brass meridian, the hour circle should be set at XII., and then the place should be rotated first to the eastern horizon and then to the western and the times on the hour circle noted, the former being the time of rising, and the latter that of setting of the sun. Twice the time of setting of the sun gives the length of the day, and twice the time of rising gives the length of the night.

Example: 20th January, 1890, sun rose, 8.15; set, 3.45.

$2 \times 3.45 = 7\frac{1}{2}$ = length of day.

$2 \times 8.15 = 16\frac{1}{2}$ = length of night.

The months and days of the months are all marked on the ecliptic, so that the sun's place for any day is determined by finding the day on the ecliptic and noting the part of the sign of the zodiac corresponding to that day, and if the globe be turned till this part of the ecliptic comes to the meridian, the latter will indicate the declination of the sun.

Note.—The *Analemma* is a convenient projection of the ecliptic on which the sun's declination may be readily found, as it is noted for every day in the year.

Numerical Facts relating to the Sun.—Solar Parallax (equatorial horizontal), $8.80'' \pm 0.02''$. Mean distance of the sun from the earth, 92,885,000 miles; 149,480,000 kilometers. Variation of the distance of the sun from the earth between January and June, 3,100,000 miles; 4,950,000 kilometers. Linear value of 1″ on the sun's surface, 450.3 miles; 724.7 kilometers. Mean angular semi-diameter of the sun, 16′ 02.0″. Sun's linear diameter, 866,400 miles; 1,394,300 kilometers. (This may, perhaps, be *variable* to the extent of several hundred miles.) Ratio of the sun's diameter to the earth's, 109.3. Surface of the sun compared with the earth, 11,940. Volume, or cubic contents, of the sun compared with the earth, 1,305,000. Mass, or quantity of matter, of the sun compared with the earth, $330{,}000 \pm 3000$. Mean density of the sun compared with the earth, 0.253. Mean density of the sun compared with water, 1.406. Force of gravity on the sun's surface compared with that on the earth, 27.6. Distance a body would fall in one second, 444.4 feet; 135.5 meters. Inclination of the sun's axis to the ecliptic, 7° 15′. Longitude of its ascending node, 74°. Date when the sun is at the node, June 4, 5. Mean time of the sun's rotation (Carrington), 25.38 days. Time of rotation of the sun's equator, 25 days. Time of rotation at latitude 20°, 25.75 days. Time of rotation at latitude 30°, 26.5 days. Time of rotation at latitude 45°, 27.5 days. (These last four numbers are somewhat doubtful, the formulæ of various authorities giving results differing by several hours in some cases.) Linear velocity of the sun's rotation at his equator, 1.261 miles per second; 2.028 kilometers per second. Total quantity of sunlight, 1,575,000,000,000,000,000,000,000,000 candles. Intensity of the sunlight at the surface of the sun, 190,000 that of a candle flame; 5300 times that of metal in a Bessemer convertor; 146 times that of a calcium light; 3.4 times that of an electric arc. Brightness of a point on the sun's limb compared with that of a point near the center of the disk, 25 per cent. Heat received per minute from the sun upon a square meter, perpendicularly exposed to the solar radiation, at the upper surface of the earth's atmosphere (*the solar constant*), 25 calories. Heat radiation at the surface of the sun, per square meter per minute, 1,117,000 calories. Thickness of a shell of ice which would be melted from the surface of the sun per minute, $48\frac{1}{2}$ feet, or $14\frac{3}{4}$ meters. Mechanical equivalent of the solar radiation at the sun's surface, continuously acting, 109,000 horse power per square meter; or, 10,000 (nearly) per square foot. Effective temperature of the solar surface (according to Rossetti), about 10,000° C., or 18,000 F.

Nebular Hypothesis.—According to this theory, all the members of our solar system once existed in a state of highly heated gaseous or nebulous matter, which extended far beyond the orbit of our most remote planet, Neptune. This matter was supposed to have received a motion of rotation, and, as it cooled, became more and more condensed, the central portion leaving a ring of protuberant matter in the equatorial region, which, after becoming detached, would continue to revolve in the same direction as the parent mass, something after the fashion of Saturn's ring. This detached ring, it was presumed, would break up, and collecting into a globular mass retain its motion of rotation, and take up an additional motion of revolution around its primary. The detached planets formed in this way would, by a similar process, throw off their satellites, which, after long ages of cooling, have assumed their present state.

SOME ELEMENTS OF THE PLANETARY SYSTEM.

Name.	Mean Distance from Earth in Millions of Miles.	Sidereal Period of Revolution Round Sun	Time of Axial Rotation.	Real Diameter in Miles.	Volume ⊕ = 1.	Density ⊕ = 1.
		D.	H. M.			
The Sun. . . . . ☉	92.9	. . . .	607 48	866,400	1,300,000	0.25
Mercury. . . . . ☿	56.9	88	*24 5½	3,030	0.056	0.85 (?)
Venus. . . . . ♀	25.7	225	*23 21⅓	7,700	0.920	0.89
Earth. . . . . ⊕	. . . .	365	23 56	7,918	1.000	1.00
Mars. . . . . ♂	48.6	687	24 37⅓	4,230	0.152	0.71
Jupiter. . . . . ♃	390.4	4,333	9 55⅓	86,500	1,309	0.24
Saturn. . . . . ♄	793.2	10,759	10 14½	73,000	760	0.13
Uranus. . . . . ♅	1,689.0	30,687	9 30 (?)	31,900	59	0.22
Neptune. . . . . ♆	2,698.8	60,181	. . . .	34,800	85	0.20

THE SOLAR SYSTEM.

	Mean distance from sun in miles.	Mean diameter in miles.	Satellites.
Sun	. . . .	860,000	. . . . .
Mercury	35,750,000	2,992	0
Venus	66.750,000	7,660	0
Earth	92,333,333	7,918	1
Mars	141,000,000	4,211	2
Jupiter	480,000,000	86,000	5
Saturn.	881,000,000	70,500	8
Uranus	1,771,000,000	31,700	4
Neptune	2,775,000,000	34,500	1

GREEK ALPHABET.

The different stars of the several constellations are usually indicated by the letters of the Greek alphabet. For convenience of reference, the alphabet is here given.

Α α Alpha.	Η η Eta.	Ν ν Nu.	Τ τ Tau.
Β β Beta.	Θ θ Theta.	Ξ ξ Xi.	Υ υ Upsilon.
Γ γ Gamma.	Ι ι Iota.	Ο ο Omicron.	Φ φ Phi.
Δ δ Delta.	Κ κ Kappa.	Π π Pi.	Χ χ Chi.
Ε ε Epsilon.	Λ λ Lambda	Ρ ρ Rho.	Ψ ψ Psi.
Ζ ζ Zeta.	Μ μ Mu.	Σ ς Sigma.	Ω ω Omega.

NAMES OF THE PRINCIPAL STARS.

The following table exhibits the names of all the Stars of the First Three Magnitudes to which Astroncmers have given names, at least all those whose names are in common use·

α Andromedæ—Andromeda..Alpheratz.
β " . . . . .Mirach Mizar.
γ " . . . . .Almach.
α Aquarii—Water Bearer. . .Sadalmelik.
β " . . . . .Sadalsund.
δ " . . . . .Skat.
α Aquilæ—Eagle. . . . . .Altair.
β " . . . . .Alshain.
γ " . . . . .Tarazed.
α Arietis—Ram. . . . . .Hamal.
β " . . . . .Sheratan.
γ " . . . . .Mesartim.
α Aurigæ—Charioteer. . . . . .Capella.
β " . . . . .Menkalinan.
α Boötis—Herdsman. . . . . . .Arcturus.
β " . . . . .Nekkar.
ε " . . . . .Izar, Mizar, Mirach.
η " . . . . .Muphrid.
α Canis Majoris—Great Dog.Sirius.
β " " . . . . .Mirzam.
ε " " . . . . .Adara.
α Canis Minoris—Little Dog.Procyon.
β " " . . . . .Gomeisa.
α Canum Venaticorum — Hunting Dogs. . . . . .Cor Caroli.
α² Capricorni—Sea Goat. . . . .Secunda Giedi.
δ " . . . . .Deneb Algiedi.
α Cassiopeiæ—Cassiopeia. . . .Schedar.
β " . . . . .Chaph.
α Cephei—Cepheus. . . . . .Alderamin.
β " . . . . .Alphirk.
γ " . . . . .Errai.
α Ceti—Whale. . . . . .Menkar.
β " . . . . .Diphda.
ζ " . . . . .Baten Kaitos
ο " . . . . .Mira.
α Columbæ—Dove. . . . . .Phact.
α Coronæ Borealis—Crown. .Alphecca.
α Corvi—Crow. . . . . .Alchiba.
δ " . . . . .Algores.
α Crateris—Cup. . . . . .Alkes.
α Cygni—Swan. . . . . . .Arided, Deneb Adige.

* The periods of rotation of Mercury and Venus are possibly equal to their periods of revolution.

N.B.—The numbers in the third column refer to the mean distances at inferior conjunction for the inferior planets at opposition for the superior planets.

—*Knowledge Diary and Scientific Handbook.*

NAMES OF THE PRINCIPAL STARS.—Continued.

β	Cygni—Swan	Albireo.
α	Draconis—Dragon	Thuban.
β	"	Alwaid.
γ	"	Etanin.
β	Eridani—River Eridanus.	Cursa.
γ	"	Zaurac.
α	Geminorum—Twins	Castor.
β	"	Pollux.
γ	"	Alhena.
δ	"	Wesat.
ε	"	Mebsuta.
α	Herculis—Hercules	Ras Algethi.
β	"	Korneforos.
α	Hydræ—Sea Serpent	Al Fard, Cor Hydræ.
α	Leonis—Lion	Regulus, Cor Leonis.
β	"	Deneb Aleet, Denedola, Deneb.
γ	"	Algeiba.
δ	"	Zosma.
α	Leporis—Wolf	Arneb.
α	Libræ—Scales	Zuben el Genubi.
β	"	Zuben el Chamali.
γ	"	Zuben Hakrabi.
α	Lyræ—Lyre	Vega.
β	"	Sheliak.
γ	"	Sulaphat.
α	Ophiuchi—Serpent Bearer	Ras Alhague.
β	"	Cebalrai.
α	Orionis—Orion	Betelgeux.
β	"	Rigel.
γ	"	Bellatrix.
δ	Orionis—Orion	Mintaka.
ε	"	Alnilam.
α	Pegasi—Pegasus	Markab.
β	"	Scheat.
γ	"	Algenib.
ε	"	Enif.
ζ	"	Homan.
α	Persei—Perseus	Mirfak.
β	"	Algol.
α	Piscis Australis—Southern Fish	Fomalhaut.
ε	Sagittarii—Archer	Kaus Australis.
α	Scorpionis—Scorpion	Antares, Cor Scorpionis.
α	Serpentis—Serpent	Unukalhai.
α	Tauri—Bull	Aldebaran.
β	"	Nath.
η	"	Alcyone (Pleiad).
α	Ursæ Majoris—Great Bear	Dubhe.
β	" "	Merak.
γ	" "	Phecda.
ε	" "	Alioth.
ζ	" "	Mizar.
η	" "	Alkaid, Benetnasch.
ι	" "	Talitha.
α	Ursæ Minoris—Little Bear	Polaris.
β	" "	Kochab.
α	Virginis—Virgin	Spica Azimech, Spica.
β	"	Zavijava.
ε	"	Vindemiatrix

MAGNITUDES AND DISTANCES OF SOME OF THE STARS.

POLARIS (ALPHA URSÆ MINORIS), THE NORTH STAR.

The parallax is 0″.075±0″.015, according to Pritchard (1888). This parallax represents 2,318,000 times the distance of the Earth from the Sun, or, in other words, Polaris is distant 210,000,000,000,000 of miles. Estimating the velocity of light as 187,500 miles per second, the light from Polaris would take thirty-six years to reach the Earth. An express train traveling a mile a minute would have to run without stopping for 479,000,000 years in order to traverse this distance.

ARCTURUS.

The parallax, as determined by Elkin in 1888, is 0″.018±0″.022, and by Peters, in 1842–43, as 0″.127±0″.073. The average 0″.094 would make the distance of Arcturus from us to be 2,194,100 times the distance from the Earth to the Sun, or 200,000,000,000,000 of miles; and taking the velocity of light as 187,500 miles, it would require thirty-four years and six months for the light to reach us.

VEGA.

This was the polar star of our Earth 14,000 years ago, and will again be the polar star in about 12,000 years. The parallax of Vega, which is 0″.15, represents 1,375,000 times the distance of the Earth from the Sun, or 12,000,000,000,000 of miles. It takes twenty years and eight months for the light from Vega to reach us, estimating the velocity of light as 187,500 miles a second.

ALTAIR.

The parallax, according to Elkin (1887), is 0″.199±0″.047. Taking the average between the parallax of Struve, 0″.181±0″.094, and that of Elkin as 0″.19, the distance would be 1,086,000 times the distance of the Earth from the Sun, or 100,000,000,000,000 miles. It would require a little over seventeen years for the light of this star to reach us.

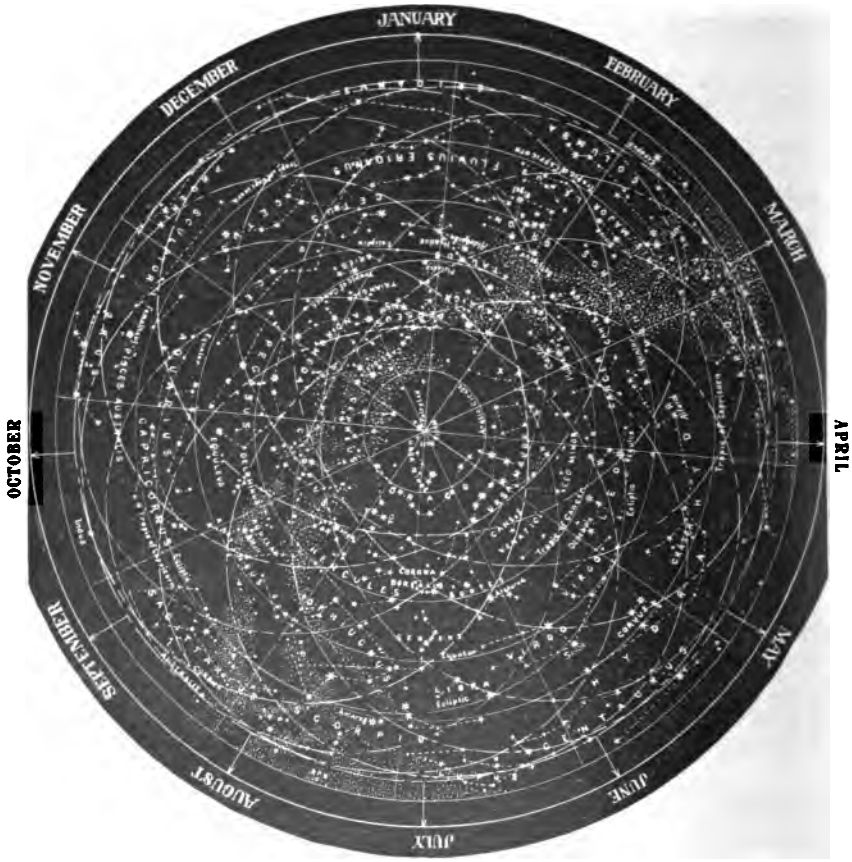
SIRIUS, THE DOG STAR.

The parallax is 0″.266±0″.047, according to Elkin (1888). Taking the average parallax of several observers as 0″.33, it would represent 625,000 times the distance of the Earth from the Sun, or 58,000,000,000,000 of miles. The light of this star would require nine years and ten months to reach us. It is supposed the diameter of Sirius is about twenty times that of the Sun, and the volume of Sirius is possibly 7,000 times greater than our Sun.

DIRECTIONS FOR USING THE STAR MAP.

Traced in dot and dash lines on the accompanying star map are a series of ellipses. From the points where these ellipses come nearest to the edge of the map, arrows project radially to the names of the months which are printed around the map. Each ellipse marks the extent of the heavens visible at nine o'clock p.m. of the first day of that month toward which its arrow points. To avoid confusion, the best plan is to cut in a piece of stiff paper an oval opening of the exact size of one of the ellipses, and to place this over the map, so as to expose to view only that portion of the map which represents the visible heavens at the

time of the observation. The map should be held with the arrow pointing toward the South, then contrary to custom in geographical maps the East will lie on the left-hand side and the West on the right-hand side. This is due to the fact that the heavens are viewed looking upward, whereas the map is viewed looking downward. In locating stars and constellations it is best to hold the map overhead, when the actual points of the compass and those marked on the map will bear the true relation to each other. Now, suppose the night be the first of December and the hour nine p.m.; cover up the entire map except that included within the ellipse whose arrow points to December. Then when the map is held overhead with the arrow pointing south it will be possible to pick out the stars visible at that hour and date. As time passes the ellipse must be slowly moved eastward around the Pole Star as a center at the rate of nearly 15 degrees per hour, so that two hours later, that is at 11 p.m., the visible heavens would correspond with that portion enclosed by the ellipse marked for the first of January. Owing to the fact that this eastward movement is not exactly 15 degrees per hour, the ellipse for the second day of December will



STAR MAP OF THE HEAVENS.

Stars of the first magnitude are indicated by an eight-point star, those of the second magnitude by a six-point star, third magnitude stars by five-point stars, fourth magnitude stars by four-point stars, and fifth magnitude stars by dots.

fall about one degree to the east of the position on the first of December at nine o'clock, so that at the end of thirty days it would move into coincidence with the ellipse traced for January 1st.

The following descriptions of the heavens apply to the stars visible at nine o'clock on the first days of the months, but it will be evident that the same description would apply for the stars visible at eight o'clock on the fifteenth of that same month, or for ten o'clock on the 15th and 11 o'clock on the first of the preceding month.

JANUARY.—The Great Bear, *Ursa Major*, is now rising well above the horizon, in the northeast, the Pointers about midway between north and northeast. The Dragon, *Draco*, lies due north, curving round under the Little Bear, its head close to the horizon. Low down in the northwest is a part of the Swan, *Cygnus*. Higher up we see King *Cepheus*, his wife, *Cassiopeia*, and their daughter, *Andromeda*, the Seated Lady and Chained Lady respectively, with the Rescuer, *Perseus*, nearly overhead. The Winged Horse is setting, his head close by the western horizon, and near the Jar of the Water Bearer, *Aquarius*. In the southwest is the Whale, and close by the constellation *Pisces*, or the Fishes; above them the Ram, *Aries*, between which and Andromeda the Triangle can be seen. In the south the River, *Eridanus*, makes now its best show. Its leading brilliant, *Achernar*, is, however, never seen in the United States. In the southwest the Great Dog with the splendid Sirius ("which brightliest shines when laved of ocean's wave") shows resplendently. Above is Orion, now standing upright, treading on the Hare, *Lepus*, and facing the Bull, *Taurus*, now at its highest. The Dove, *Columba*, below the Hare is a modern and not very interesting constellation. The Little Dog, *Canis Minor*, is on the east of Orion. In the east the Sea Serpent, *Hydra*, is rising, and due east a little higher we find *Cancer*, the Crab; above are the Twins, *Gemini*, and above them the Charioteer, *Auriga*, with the bright Capella, nearly overhead. The Lion is rising in the northeast, his heart star, Regulus, being low down a little north of east.

FEBRUARY.—The Great Bear, *Ursa Major*, with its Dipper and Pointers, occupies the northeasterly midheaven. The Dragon, *Draco*, curves round the Little Bear toward the Pointers. In the northwest, fairly high up, we find *Cassiopeia*, the Seated Lady, and on her right, lower down, the inconspicuous constellation *Cepheus*. *Andromeda*, the Chained Lady, is on Cassiopeia's left. Above Andromeda is *Perseus*, the Rescuing Knight and above him the Charioteer, *Auriga*, nearly overhead. On the left of Andromeda is *Aries*, the Ram, the small constellation the Triangle lying between them. Toward the southwest, the Whale, *Cetus*, is beginning to set. The River, *Eridanus*, occupies the lower part of the southwesterly sky, and extends also to the midheavens in that direction. The Dove, *Columba*, lies toward the south, and is at its best, which is not saying much. Above is the Hare, *Lepus*, on which *Orion* treads. The giant now presents his noblest aspect—prince of all the constellations, as he is. He faces the Bull, *Taurus*, known by the Pleiades and the bright Aldebaran. Close by the poor Hare, on the left, leaps *Canis Major*, the Greater Dog, with the bright Sirius, which "bickers into green and emerald." The stern of the Star-Ship, *Argo*, is nearing the south. Very high in the southeast we find the Twins, *Gemini*, with the twin stars, Castor and Pollux, and below them the Little Dog, *Canis Minor*. The Sea Serpent, *Hydra*, is rearing its tall neck above the eastern horizon (by south), as if aiming either for the Little Dog or for the Crab, *Cancer*, now high up in the east, with its pretty Beehive cluster showing well in clear weather. The Lion, *Leo*, is due east, the Sickle being easily recognized.

MARCH.—The Great Bear, *Ursa Major*, with its Dipper and Pointers, is now high up in the northeastern sky. The Dragon, *Draco*, extends from between the Bears to the horizon, east of north, where its head with its two bright eyes can be seen. *Cepheus* is low down, somewhat to the west of north; his Queen, *Cassiopeia*, the Seated Lady, beside him. *Andromeda*, the Chained Lady, is in the northwest, low down—in fact, partly set; the Triangle, and next the Ram, *Aries*, beside her, toward the west. Above them is *Perseus*, the Rescuing Knight; and above him, somewhat to the west, the Charioteer, *Auriga*. The Bull, *Taurus*, with the Pleiades and the bright Aldebaran, is in the midheaven, due west; *Gemini*, the Twins, higher, and toward the southwest. Orion, below them, is already slanting toward his grave, low down in the west; beneath him the Hare, and in the southwest a part of the River, *Eridanus*. Due south is a part of the Star Ship, *Argo*, beside which, low down, is the foolish Dove, *Columba*, while above leaps the Great Dog, *Canis Major*, with the splendid Sirius, chief of all the stars in the sky, marking his mouth. High up, a little west of north, is the Little Dog, *Canis Minor*, and higher, a little east of north, the Crab, *Cancer*, the dark constellation, as it was called of old, with the pretty cluster, *Præsepe*, or the Beehive. The Sea Serpent, *Hydra*, is rearing his long neck high above the horizon, bearing, absurdly enough, on his back Noah's Cup, *Crater*, and Noah's Raven, or Crow, *Corvus*. Nearly due east, the Virgin, *Virgo*, has risen. The Lion, *Leo*, occupies the midspace above. East of the Great Bear lies Hevelius's foolish constellation, the Hunting Dogs, *Canes Venatici*. Lastly, in the northeast, the Herdsman, *Bootes*, with the orange-yellow brilliant Arcturus, is rising, though at present, paradoxical as it may seem, he lies on his back.

APRIL.—The Great Bear, *Ursa Major*, is now nearing the point overhead, the Pointers, aiming almost directly downward toward the Pole Star. *Cepheus* lies north, low down; *Cassiopeia* on his left. Perseus is nearing the horizon, the Charioteer, *Auriga*, on his left, but higher. Setting toward the west we see the Bull, *Taurus*, with the Pleiades and the ruddy Aldebaran. *Orion* is almost prone in his descent toward his western grave. The Twins, *Gemini*, are due west, in the midheavens; the Little Dog, *Canis Minor*, beside them on their left; the Crab, *Cancer*, above; the Greater Dog, *Canis Major* below, chasing the Hare, *Lepus*, below the horizon. Just behind the Dog the poop of the Great Ship, *Argo*, is also setting. The Sea Serpent, *Hydra*, now shows his full length, rearing

his head high in the south. Observe the darkness of the region around his heart. *Alfard*, the Solitary One. The Cup, *Crater*, and Crow, *Corvus*, stand on his back. The Sickle in the Lion, *Leo*, now stands with handle upright, due south. Below the tail stars of the Lion we see the Virgin, *Virgo*. The Herdsman, *Bootes*, still on his back pursues in that striking and effective position the Great Bear. Below the shoulder stars of the Herdsman we see the Crown, *Corona Borealis*, near which, on the right, low down and due east, the head of the Serpent, *Serpens*, is rising.

MAY.—The Great Bear, *Ursa Major*, is now at its highest and nearly overhead, the Pointers aiming downward from high up, slightly west of due north. Below the Little Bear we find *Cepheus* low down to the east of north, and *Cassiopeia* low down to the west of north. *Perseus*, the Rescuer, is setting in the northwest. The Charioteer, *Auriga*, with the bright Capella, is nearing the northwestern horizon, followed by the Twins, *Gemini*, in the west. Further west and higher we find the Crab, *Cancer*, below which is the Little Dog, *Canis Minor*. The southwestern sky is very barren of bright stars, *Alfard*, the heart of the Sea Serpent, *Hydra*, shining alone in a great blank space. Above the Sea Serpent's head we see the Sickle in the Lion, *Leo*, himself stretching his tail to due south, very high up. In the south, lower down, we find the Crow, *Corvus*, and the Cup, *Crater*, on the Serpent's back; the Virgin, *Virgo*, extending in the midheavens from southeast to south, between the Lion's tail and the Crow. In the same direction, but low down, we find the head and body of the Centaur, *Centaurus*, supposed to have typified the patriarchal Noah. In the southeast the Scorpion is just beginning to appear, and between the head of *Scorpio* and the Virgin's robes we see the stars of the Scales, *Libra*. Due east, low down, is the Serpent Bearer, *Ophiuchus*, on his back—'tis the customary attitude of heavenly bodies when rising. The Serpent, *Serpens*, held by him is seen curving upward toward the Crown, *Corona Borealis*. The Serpent's head is due west, and above it we see the bright Arcturus, chief brilliant of the Herdsman, *Bootes*. In the northeast is *Hercules*, his head close to the head of the Serpent Bearer. Beneath his feet is the Lyre, *Lyra*, with the brilliant Vega; and the Swan, *Cygnus*, has already half risen above the northeastern horizon. Lastly, the Dragon, *Draco*, curves from between the Pointers and the Pole, round the Guardians, toward Cepheus, and then retorts its head with gleaming eyes, β and γ, toward the heel of Hercules.

JUNE.—The Great Bear, *Ursa Major*, occupies all the upper sky from west to north, except a small space occupied by the Hunting Dogs, *Canes Venatici*. Due south, low down, lies *Cassiopeia*, while above, somewhat toward the east, we find the inconspicuous constellation *Cepheus*. Low down in the northwest lie the Charioteer, *Auriga*, and the head stars of the Twins, *Gemini*, farther west. The Crab, *Cancer*, is nearly due west, the Sea Serpent, *Hydra*, holding his head almost exactly to the west point. Above is the Sickle in the Lion, its blade curved downward, and the tail of the Lion, *Leo*, lies above, toward the south of west. On the Serpent's back we find the Cup, *Crater*, and the Crow, *Corvus*, in the southwest and to the south of southwest respectively. Above these constellations the Virgin, *Virgo*, occupies the midheavens. Above the Virgin we see the Herdsman, *Bootes*, his head and shoulders nearly overhead. Low down in the south is the Centaur, *Centaurus*, bearing on his spear the Wolf, *Lupus*, as an offering for the Altar, *Ara*, which, however, is invisible in these latitudes. Above the Wolf we see the Scales, *Libra*, while the Scorpion, *Scorpio*, one of the few constellations which can at once be recognized by its shape, is rising balefully in the southeast. Te Serpent Bearer, *Ophiuchus*, bears the Serpent, *Serpens*, in the midheavens toward the southeast, the Crown, *Corona Borealis*, being high up in the east, close by the Serpent's head. Low down in the east is the Eagle, *Aquila*, with the fine steel blue star Altair, the Swan on the left about northeast, and above it the Lyre, *Lyra*, with the still more brilliant steel blue star *Vega*. Hercules occupies the space between the Lyre on the one side and the Crown and the Serpent's head on the other. He is high up, due east.

JULY.—The Great Bear, *Ursa Major*, is in the midheavens toward the northwest, the Pointers not far from the horizontal position. The Dragon, *Draco*, curls over the Little Bear, curving upward on the east, to where its head, high up in the northeast, is marked by the gleaming eyes, β and γ. Low down in the West the Lion, *Leo*, is setting. The point of the "Sickle in the Lion" is turned to the horizon; the handle is nearly horizonatal. The Crow, *Corvus*, is low down in the southwest, the Cup, *Crater*, beside it, partly set, on the right. Above is *Virgo*, the Virgin. Still higher in the southwest—in fact, with head close to the point overhead—is the Herdsman, *Bootes*, the Crown, *Corona Borealis*, near his southern shoulder marking what was once the Herdsman's uplifted arm. Low down between the south and southwest we find the head and shoulders of the Centaur, *Centaurus*, who holds the Wolf, *Lupus*, due south. In the midsky, toward the southeast, we find the Serpent Holder, *Ophiuchus*. Below the Serpent Holder we find the Scorpion, *Scorpio*, now fully risen, and showing truly scorpionic form. Beside the Scorpion is the Archer, *Sagittarius*, low down in the southeast. Above, near the point overhead, is the kneeling *Hercules*. Due east, we see part of the Winged Horse, *Pegasus:* above that, the little Dolphin, *Delphinus:* and higher, the Swan, *Cygnus*, and the Lyre, *Lyra*, with the beautiful bluish-white star Vega. Lastly, low down, between north and northeast, we find the Seated Lady, *Cassiopeia:* and above, somewhat eastwardly, the inconspicuous constellation *Cepheus*, Cassiopeia's royal husband.

AUGUST.—The Great Bear, *Ursa Major*, is now in the northwest, his paws near the horizon. The Dragon, *Draco*, curves round from between the Pointers and the Pole, above the Little Bear toward the east, then upward to near the point overhead, its head, with the bright stars β and γ, being highest. The Herdsman, *Bootes*, occupies the midheavens in the west, the Crown, *Corona Borealis*, higher up, and due west Hercules, between the Crown and the point overhead. Low down, extending from the west to near the southwest, we find the Virgin, *Virgo*, the bright

Spica near its setting place. In the southeast are the Scales, *Libra*, and, farther to the left, extending from the Scales to low down near the south, we find the Scorpion, *Scorpio*, one of the finest of the constellations, Antares, the rival of Mars (as the name means), marking its heart. Above the Scorpion and the Scales are the Serpent Holder, *Serpentarius* or *Ophiuchus*, and the Serpent, *Serpens*, extending right across him to near the Crown, after which the Serpent seems reaching. A little east of due south, low down, we find the Archer, *Sagittarius:* in the southeast, low down, the Sea Goat, *Capricornus:* and farther east, and lower down, the Water Bearer, *Aquarius*. Above the Sea Goat is the Eagle, *Aquila*, with the bright bluish-white star Altair; on its left, the pretty little Dolphin, *Delphinus*, and above the Dolphin, nearly overhead, the Lyre, *Lyra*, with the bluish-white star Vega (even brighter than Altair) nearly overhead. Below the Lyre we see the Swan, *Cygnus*, due east; and below the Swan the Winged Horse, *Pegasus*, upside down, as usual. In the northeast, *Andromeda*, the Chained Lady, is rising. Between the north and northeast is *Cassiopeia*, the Seated Lady, and above her, her husband, King Cepheus.

September.—The Great Bear, *Ursa Major*, is low down, between northwest and north, the Pointers directed slantingly upward toward the Pole. Between the Great Bear and the Little Bear run the stars of the Dragon, *Draco*, round the Little Bear toward the north, thence toward the northwest, where we see the head of the Dragon high up, his two bright eyes, directed toward *Hercules*, which occupies the western mid-heaven. Above Hercules is the Lyre, *Lyra*, with the bright steel-blue star Vega high up toward the point overhead. Right overhead is the Swan, *Cygnus*. Near the west stands the Herdsman, rather slanting forward, however, with the Crown, *Corona Borealis*, on his left, almost due west. The long winding Serpent, *Serpens*, runs from near the Crown, where we see its head, due west to farther south than southwest, high up, on the western side of the Serpent Holder, *Serpentarius* or *Ophiuchus*, now standing upright in the southwest. Low down creeps the Scorpion, *Scorpio*, its heart Antares, rival of Mars, in the southwest, the end of its tail between south and southwest. Above, and south of the Scorpion's tail, we see the Archer, *Sagittarius*. Due south and high up is the Eagle, *Aquila*, the bright steel-blue Altair marking its body. On the left, or east, of the Eagle lies the neat little Dolphin, *Delphinus*. Midway between the Dolphin and the horizon is the tip of the tail of the Sea Goat, *Capricornus*, whose head lies nearly due south. On the southern horizon is the head of the Indian, *Indus;* and low down in the southeast lies Fomalhaut, the chief brilliant of the Southern Fish, *Piscis Australis*. Above lies the Water Bearer, *Aquarius*, in the southwestern midheaven. Due east, fairly high, is the "Square of Pegasus," the head of the Winged Horse, *Pegasus*, lying close by the Water Pitcher of Aquarius. The Fishes, *Pisces*, are low down in the east. On the left of Pisces we see the Ram, *Aries*, low down; above it, the Triangle; and above that, the Chained Lady, *Andromeda*. Low down in the northeast is the Rescuing Knight, *Perseus;* above whom is *Cassiopeia;* and on her left, higher up, the inconspicuous constellation *Cepheus*.

October.—Low down between north and northwest we find the seven stars of the Dipper, the Pointers on the right nearly due north. They direct us to the Pole Star. Between the Pointers and the Pole Star we find the tip of the Dragon's tail, and sweep round the Little Bear with the Dragon's long train of third magnitude stars, till we come, after a bend, to the Dragon's head, with the two bright eyes, β and γ. These two stars are almost exactly midway between the horizon and the point overhead, and nearly northwest. King Cepheus—not a very conspicuous constellation—lies between the point overhead and the Little Bear. Low down in the northwest we find the head of the Herdsman, *Bootes*. The Crown, *Corona Borealis*, which no one can mistake, lies on his left, and close by is the setting head of the Serpent. Above these three groups we see Hercules—the Kneeler. Above the head of Hercules we find the Lyre, with the bright star Vega; and above that the Swan. Passing southward, we see the Serpent Holder, *Serpentarius* or *Ophiuchus*, beyond whom lies the Serpent's tail, a most inconvenient arrangement, as the Serpent is divided into two parts. Almost exactly southeast, and low down, are the stars of the Archer, *Sagittarius;* while above, in the mid-sky, we see the Eagle, *Aquila*, with the bright Altair. Note the neat little constellation, the Dolphin, *Delphinus*, close by. Due south is the Crane, *Grus;* above it, the Southern Fish, with the bright star Fomalhaut; above that, the Sea Goat, *Capricornus*, and on the left of this the Water Bearer, *Aquarius;*. Toward the east, high up, is the Winged Horse, *Pegasus;* he is upside down just now. Below lies the Whale, *Cetus*, or, rather, the Sea Monster. The Fishes, *Pisces*, may be seen between the Whale and Pegasus. Few constellations have suffered more than Pisces by the breaking up of star groups. The fishes themselves are now lost in Andromeda and Pegasus. Note how, on the left of Pisces the Ram, *Aries*, "bears aloft" Andromeda, the Chained Lady, as Milton set Aries doing long since. The Triangle serves only as a saddle. Between Andromeda and her father, Cepheus, we find her mother, Cassiopeia, or, rather, Cassiopeia's Chair. Perseus, the Rescuer, lies below.

November.—The Dipper lies low, the Pointers a little east of north. Between the Pointers and Pole Star lies the tip of the Dragon's tail. Low down in the northwest, Hercules is setting. Above is the Lyre, with the bright steel-blue Vega; and above that the stars of the Swan, *Cygnus*, which has sometimes been called the Northern Cross. Nearly due west we find the Eagle, *Aquila*. Above the Eagle is the pretty little constellation the Dolphin, *Delphinus*. In the southwest, rather low, is the Sea Goat, *Capricornus;* above, and to the south of him, the Water Bearer, *Aquarius*. The head of the Winged Horse, *Pegasus*, now upside down (in fact, he is seldom otherwise), is just above this group. Much attention need not be directed to the lowly *Phoenix*, low in the southern horizon. The River, *Eridanus*, is coming well into view; and the great Sea Monster, *Cetus*, now shows finely. The Fishes, *Pisces*,

are above; the Ram, *Aries*, above them, and eastward, lying toward the southeast; then the Triangle, *Triangula* (or the Triangles, according to modern maps), and the Chained Lady, *Andromeda*, too nearly overhead to be very pleasantly observed. The grand giant, *Orion*, is rising in the east; above him, the Bull, *Taurus*, with the Pleiades. Low down in the northeast the Twins, *Gemini*, are rising; above is the Charioteer, *Auriga*, and above him the Rescuing Knight, *Perseus*, "of fair-haired Danaë born."

DECEMBER.—The Great Bear, *Ursa Major*, is beginning to rise above the northeast by north horizon. The end of the Dipper's handle is hidden. The stars of the Dragon wind round below the Little Bear toward the west, the head of the Dragon with the gleaming eyes ("oblique retorted that askant cast gleaming fire") being low down, a little north of northwest. Above is King Cepheus, and above him his queen, the Seated Lady, *Cassiopeia*, their daughter, the Chained Lady, *Andromeda*, being nearly overhead. Low down in the northwest we see the Lyre, *Lyra*, with the bright Vega, and close by toward the west the Swan, *Cygnus*, or Northern Cross. The Eagle is setting in the west, and the little Dolphin nears the western horizon. Toward the southwest by west we see the Water Bearer, *Aquarius*, with his Pitcher, close by which is the head of the Winged Horse, *Pegasus*. In the south, low down, is the absurd Phœnix; above, the Sea Monster, or Whale, *Cetus;* above him, the Fishes, *Pisces;* above them, the Ram, *Aries;* while nearly overhead lies the Triangle. The River *Eridanus*. occupies the southeasterly sky, the Dove and Great Dog, *Columba* and *Canis Major*, rising in the southeast. The glorious Orion has now come well into position, though not yet so upright as we could wish a knightly hunter to be. He treads on the Hare, *Lepus*, and faces the Bull, *Taurus*, above. Due east we find the Crab, *Cancer*, and Little Dog, *Canis Minor*, low down; the Twins, *Gemini*, higher; above them the Charioteer, *Auriga*, with the bright *Capella*, and *Perseus*, the Rescuer, nearing the point overhead.—*R. A. Procter's Star Maps.* Copyright, 1903, by Munn & Co.

THE LARGE REFRACTORS OF THE WORLD.

Institution.	Aperture in Inches.	Focal Length in Feet.	Date of Erection.
Yerkes Observatory, Wisconsin, U. S. A.	40.0	62.0	1897
Lick Observatory, California, U. S. A.	36.0	57.8	1888
Lick Observatory, California, U. S. A.	33.0	49.2	....
National Observatory, Meudon.	32.5	53.0	1891
Astrophysical Observatory, Potsdam.	31.1	39.4	....
Bischoffsheim Observatory, Nice.	30.3	52.6	1889
Imperial Observatory, Poulkova.	30.0	42.0	1882
National Observatory, Paris.	28.9	....	....
Royal Observatory, Greenwich.	28.0	28.0	1894
Imperial Observatory, Vienna.	27.0	34.0	1894
Royal Observatory, Greenwich.	26.0	26.0	1897
Naval Observatory, Washington.	26.0	32.5	1871
Leander McCormick Observatory, Virginia, U. S. A.	26.0	32.5	1874
Cambridge University Observatory.	25.0	....	1868
National University, Meudon.	24.4	52.2	1891
Harvard College, Cambridge, U. S. A.	24.0	11.3	1894
Royal Observatory, Cape of Good Hope.	24.0	22.6	1897
Lowell Observatory, Mexico.	24.0	31.0	1895
National Observatory, Paris.	23.6	59.0	1889
Halstead Observatory, Princeton, U. S. A.	23.0	32.0	1881
Etna.	21.8	....	....
Buckingham Observatory.	21.2	....	....
M. Porro, Private Observatory, Italy.	20.5	....	....
Chamberlin Observatory, Colorado, U. S. A.	20.0	28.0	1891
Manila Observatory, Philippines.	20.0	....	1892
Astrophysical Observatory, Potsdam.	19.7	41.2	....
Imperial Observatory, Strassburg.	19.1	23.0	1880
Milan Observatory, Italy.	19.1	23.0	....
North-Western Observatory, Illinois, U. S. A.	18.5	27.0	1863
Dearborn Observatory.	18.5	....	....
National Observatory, La Plata.	18.1	29.5	1890
Lowell Observatory, Mexico.	18.0	26.3	1894
Flower Observatory, Philadelphia, U. S. A.	18.0	....	1896
Vander Zee Observatory.	18.0	....	....
Royal Observatory, Cape of Good Hope.	18.0	22.6	1897

—Knowledge Diary and Scientific Handbook.

PART IV.

WEIGHTS AND MEASURES.

LINEAR MEASURE.

3 barleycorns, or. . .	1 inch (in.)
12 lines, or.	
72 points, or.	
1,000 mils (mi.)	
3 inches.	1 palm
4 inches.	1 hand
9 inches.	1 span
12 inches.	1 foot (ft.)
18 inches.	1 cubit
3 feet.	1 yard (yd.)
2½ feet.	1 military pace
5 feet.	1 geometrical pace
2 yards.	1 fathom
5½ yards.	1 rod, pole, or perch
66 feet, or.	1 Gunter's chain
4 rods.	
40 poles, or.	1 furlong (fur.)
220 yards.	
8 furlongs, or.	1 mile
1,760 yards, or.	
5,280 feet.	
3 miles.	1 league

The hand is used to measure horses' height. The military pace is the length of the ordinary step of a man. One thousand geometrical paces were reckoned to a mile.

LAND MEASURE (LINEAR).

7.92 inches.	1 link
100 links, or.	1 chain (ch.)
66 feet, or.	
22 yards, or.	
4 poles.	
10 chains.	1 furlong (fur.)
80 chains, or.	1 mile
8 furlongs.	

LAND MEASURE (SQUARE).

144 sq. inches. . .	1 square foot (sq. ft.)
9 square feet. .	1 square yard (sq. yd.)
30¼ sq. yards. . .	1 sq. pole, rod, or perch
16 sq. poles. . . .	1 square chain (sq. ch.)
40 sq. poles, or	1 sq. rood
1,210 sq. yards. .	
4 roods, or . .	1 acre *
10 sq. chs., or .	
160 sq. poles, or	
4,840 sq. yds., or.	
43,560 sq. ft	
640 acres, or. . .	1 sq. mile
3,097,600 sq. yds	
30 acres.	1 yard of land
100 acres.	1 hide of land
40 hides.	1 barony

CUBIC MEASURE.

1,728 cubic inches.	1 cubic foot
27 cubic feet.	1 cubic or solid yard

* The side of a square having an area of an acre is equal to 69.57 linear yards.

GEOGRAPHICAL AND NAUTICAL MEASURE.

6086.44 feet, or	= 1 nautical mile or knot
1000 fathoms, or. . . .	
10 cables, or.	
1.1528 statute miles. . .	
60 nautical miles, or	= 1 degree
67.168 statute miles. . .	
360 degrees.	= 1 circumference of the earth at the equator
1 league.	= 3 nautic'l miles
1 cable's length . . .	= 120 fathoms

DRY MEASURE, U. S.

		Cu. In.
2 pints.	1 quart (qt.)	= 67.20
4 quarts.	1 gallon (gal.)	= 268.80
2 gallons, or.	1 peck	= 537.60
8 quarts.		
4 pecks.	1 struck bushel	= 2150.42

LIQUID MEASURE, U. S.

		Cu. In.
4 gills.	1 pint (O.)	= 28.875
2 pints.	1 quart (qt.)	= 57.75
4 quarts.	1 gallon (gal.)	= 231.
63 gallons.	1 hogshead (hhd.)	
2 hogsheads . . .	1 pipe or butt	
2 pipes.	1 tun	

APOTHECARIES' LIQUID MEASURE.

Apothecaries' or Wine Measure is used by pharmacists of this country. Its denominations are gallon, pint, fluid ounce, fluid drachm, and minim, as follows:

Cong.	O.	F. Oz.	F. Dr.	Minims.
1 =	8 =	128 =	1,024 =	61,440
	1 =	16 =	128 =	7,680
		1 =	8 =	480
			1 =	60
				1

The Imperial Standard Measure is used by British pharmacists. Its denominations and their relative value are:

Gal.	Quarts.	Pints.	F. Oz.	F. Dr.	Minims.
1 =	4 =	8 =	160 =	1,280 =	76,800
	1 =	2 =	40 =	320 =	19,200
		1 =	20 =	160 =	9,600
			1 =	8 =	480
				1 =	60

The relative value of United States Apothecaries' and British Imperial Measures is as follows:

U. S. Apothecaries' Measure.	Imperial Measure.	Pints.	F. Oz.	F. Dr.	Minims
1 Gallon =	.83311 Gallon, or	6	13	2	22.85
1 Pint =	.83311 Pint, or		16	5	17.86
1 Fl. Oz. =	1.04139 Fl. Oz., or		1	0	19.86
1 Fl. Dr. =	1.04139 Fl. Dr., or			1	2.48
1 Minim =	1.04139 Minim, or				1.04

OLD WINE AND SPIRIT MEASURE.

			Imperial Gals.
4 gills or quarterns	1 pint		
2 pints	1 quart		
4 quarts (231 cu. in.)	1 gallon	=	.8333
10 gallons	1 anchor	=	8.333
18 gallons	1 bunlet	=	15
31½ gallons	1 barrel	=	26.25
42 gallons	1 tierce	=	35
63 gallons, or 2 barrels	1 hogshead	=	52.5
84 gallons, or 1⅓ hogsheads	1 puncheon	=	70
126 gallons, or 2 hogsheads or 1½ puncheons	1 pipe or butt	=	105.
2 pipes or 3 puncheons	1 tun	=	210

Apothecaries' Weight is the officinal standard of the United States Pharmacopœia. In buying and selling medicines not ordered by prescriptions avoirdupois weight is used.

Lb.		Oz.		Dr.		Scr.		Gr.
1	=	12	=	96	=	288	=	5760
		1	=	8	=	24	=	480
				1	=	3	=	60
						1	=	20

Avoirdupois Weight.—Used for weighing all goods except those for which troy and apothecaries' weight are employed.

Gross or Long Ton.		Cwt.		Qr.		Lb.		Oz.		Dr.
1	=	20	=	80	=	2,240	=	35,840	=	573,440
		1	=	4	=	112	=	1,792	=	28,672
				1	=	28	=	448	=	7,168
						1	=	16	=	256
								1	=	16

Short or Net Ton.		Cwt.		Qr.		Lb.		Oz.		Dr.
1	=	20	=	80	=	2,000	=	32,000	=	512,000
		1	=	4	=	100	=	1,600	=	25,600
				1	=	25	=	400	=	6,400
						1	=	16	=	256
								1	=	16

The "short" ton of 2,000 lbs. is used commonly in the United States. The British or "long" ton, used to some extent in the United States, contains 2,240 lbs., corresponding to a cwt. of 112 and a quarter of 28 lbs.

Troy Weight.—Used by jewelers and at the mints, in the exchange of the precious metals.

Lb.		Oz.		Dwt.		Gr.
1	=	12	=	240	=	5760
		1	=	20	=	480
				1	=	24

7000 troy grains	=	1 lb. avoirdupois.
175 troy pounds	=	144 lb. avoirdupois.
175 troy ounces	=	192 oz. avoirdupois.
437½ troy grains	=	1 oz. avoirdupois.
1 troy pound	=	.8228+ lb. avoirdupois.

The common standard of weight by which the relative values of these systems are compared is the grain, which for this purpose may be regarded as the unit of weight. The pound troy and that of apothecaries' weight have each five thousand seven hundred and sixty grains; the pound avoirdupois has seven thousand grains.

The relative proportions and values of these several systems are as follows:

Troy.	Avoirdupois. Oz.	Dr.
1 pound equals	13	2.65
1 ounce equals	1	1.55
1 dwt. equals	0	0.877

Troy.	Apothecaries'. Lb.	Oz.	Dr.	Scr.	Gr.
1 pound equals	1	0	0	0	0
1 ounce equals	0	1	0	0	0
1 dwt. equals	0	0	0	1	4
1 grain equals	0	0	0	0	1

Apothecaries'.	Avoirdupois. Oz.	Dr.
1 pound equals	13	2.65
1 ounce equals	1	1.55
1 drachm equals	0	2.19
1 scruple equals	0	0.73

Apothecaries'.	Troy. Lb.	Oz.	Dwt.	Gr.
1 pound equals	1	0	0	0
1 ounce equals	0	1	0	-0
1 drachm equals	0	0	2	12
1 scruple equals	0	0	0	20

Avoirdupois.	Troy. Lb.	Oz.	Dwt.	Gr.
1 long ton equals	2722	2	13	8
1 cwt. equals	136	1	6	16
1 quarter equals	34	0	6	16
1 pound equals	1	2	11	16
1 ounce equals	...	0	18	5½
1 drachm equals	...	0	1	3 11/32

Avoirdupois.	Troy. Lb.	Oz.	Dwt.	Gr.
1 short ton equals	2430	6	13	8
1 cwt. equals	121	6	6	16
1 quarter equals	30	4	11	16

Avoirdupois.	Apothecaries'. Lb.	Oz.	Dr.	Scr.	Gr.
1 pound equals	1	2	4	2	0
1 ounce equals	0	0	7	0	17½
1 drachm equals	0	0	0	1	7 11/32

Diamond Measure.

16 parts = 1 grain = 0.8 troy grains.
4 grains = 1 carat = 3.2 troy grains.

Household Measures.—Nothing is more vague and inaccurate than such expressions as: "A cupful, a wineglass." An attempt has been made to reduce these measures to some scale. In these liquid measures the glass is supposed to be filled ⅛ inch from the top. A "wineglass" is very apt to be a claret glass. If the diameter is 2⅝ inches and the depth 2⅛ inches from rim to bottom, the glass will hold 3½ fl. oz. = 105 cubic centimeters. A sherry glass is also a common wine glass and is flaring. If its top is 2¼ inches in diameter it should hold 1½ fl. oz., or 45 cubic centimeters, A liquor glass, usually called a whiskey glass, varies greatly, but if 3 inches high and 2¼ inches in diameter and slightly flaring it holds 4 fl. oz., or 120 cubic centimeters. A cocktail glass is peculiar; the diameter of the "Union League" model is 2¼ inches, depth 1⅝ inch, round flare, holds 2 fl. oz. = 60 cubic centimeters. A "liqueur" glass having a diameter of 1⅛ inches, 2⅛ inches deep, flaring sides, holds ⅔ of a fluid ounce, or 20 cubic centimeters. A straight-sided soda glass, 6⅜ inches high by 2⅝ inches in diameter, holds 10 fl. oz., or 300 cubic centimeters. A 3/10 liter stein, 2⅞ inches in diameter and 3⅜ inches deep, holds 10 fl. oz., or 300 cubic centimeters as ordinarily filled.

120 drops water = 1 teaspoon	$2\frac{1}{2}$ cups buckwheat flour = 1 lb.
60 " thick fluid = 1 "	$5\frac{1}{3}$ " coffee = 1 "
60 " " " = 1 oz.	$6\frac{1}{2}$ " tea = 1 "
2 teaspoons = 1 dessert-spoon	2 " rice = 1 "
3 " = 1 tablespoon	2 " lard = 1 "
16 tablespoons = 1 cup	2 " butter = 1 "
1 cup = 1 pint	2 " graham flour = 1 "
1 " water = $\frac{1}{2}$ lb.	2 " rye flour = 1 "
4 tablespoons flour = 1 oz.	2 " corn meal = 1 "
2 tablespoons butter = 1 "	2 " rolled oats = 1 "
3 teaspoons soda = $\frac{1}{2}$ "	2 " powdered sugar = 1 "
4 " baking powder = $\frac{1}{2}$ "	2 " brown " = 1 "
2 cups granulated sugar = 1 lb.	2 " raisins = 1 "
$2\frac{1}{2}$ " confectioners' sugar = 1 "	2 " currants = 1 "
$2\frac{1}{2}$ " wheat flour = 1 "	2 " bread crumbs = 1 "
$3\frac{1}{2}$ " whole-wheat flour = 1 "	9 eggs = 1 "

FOREIGN WEIGHTS AND MEASURES.

The following table embraces only such weights and measures as are given from time to time in CONSULAR REPORTS and in COMMERCIAL RELATIONS:

Foreign weights and measures, with American equivalents.

Denominations.	Where Used.	American Equivalents.
Almude	Portugal	4.422 gallons.
Ardeb	Egypt	7.6907 bushels.
Are	Metric	0.02471 acre.
Arobe	Paraguay	25 pounds.
Arratel or libra	Portugal	1.011 pounds.
Arroba (dry)	Argentine Republic	25.3175 pounds.
Do.	Brazil	32.38 pounds.
Do.	Cuba	25.3664 pounds
Do.	Portugal	32.38 pounds.
Do.	Spain	25.36 pounds.
Do.	Venezuela	25.4024 pounds.
Arroba (liquid)	Cuba, Spain, and Venezuela	4.263 gallons.
Arshine	Russia	28 inches.
Arshine (square)	Do.	5.44 square feet.
Artel	Morocco	1.12 pounds.
Baril	Argentine Republic and Mexico	20.0787 gallons.
Barrel	Malta (customs)	11.4 gallons.
Do.	Spain (raisins)	100 pounds.
Batman or tabriz	Persia	6.49 pounds.
Berkovets	Russia	361.12 pounds.
Bongkal	India	832 grains.
Bouw	Sumatra	7,096.5 square meters.
Bu	Japan	0.1 inch.
Butt (wine)	Spain	140 gallons.
Caffiso	Malta	5.4 gallons.
Candy	India (Bombay)	529 pounds.
Do.	India (Madras)	500 pounds.
Cantar	Morocco	113 pounds.
Do.	Syria (Damascus)	575 pounds.
Do.	Turkey	124.7036 pounds.
Cantaro (cantar)	Malta	175 pounds.
Carga	Mexico and Salvador	300 pounds.
Catty	China	$1.333\frac{1}{3}$ ($1\frac{1}{3}$) pounds.
Do.[1]	Japan	1.31 pounds.
Do.	Java, Siam, and Malacca	1.35 pounds.
Do.	Sumatra	2.12 pounds.
Centaro	Central America	4.2631 gallons.
Centner	Bremen and Brunswick	117.5 pounds.
Do.	Darmstadt	110.24 pounds.
Do.	Denmark and Norway	110.11 pounds.
Do.	Nuremberg	112.43 pounds.
Do.	Prussia	113.44 pounds.
Do.	Sweden	93.7 pounds.
Do.	Vienna	123.5 pounds.
Do.	Zollverein	110.24 pounds.

[1] More frequently called "kin." Among merchants in the treaty ports it equals $1.33\frac{1}{3}$ pounds avoirdupois.

FOREIGN WEIGHTS AND MEASURES—*Continued.*

Denominations.	Where Used.	American Equivalents.
Centner	Double or metric	220.46 pounds.
Chetvert	Russia	5.7748 bushels.
Chih	China	14 inches.
Coyan	Sarawak	3,098 pounds
Do	Siam (Koyan)	2,667 pounds.
Cuadra	Argentine Republic	4.2 acres.
Do	Paraguay	78.9 yards.
Do	Paraguay (square)	8.077 square feet.
Do	Uruguay	Nearly 2 acres.
Cubic meter	Metric	35.3 cubic feet.
Cwt. (hundredweight)	British	112 pounds.
Dessiatine	Russia	2.6997 acres.
Do	Spain	1.599 bushels.
Drachme	Greece	Half ounce.
Fanega (dry)	Central America	1.5745 bushels.
Do	Chile	2.575 bushels.
Do	Cuba	1.599 bushels.
Do	Mexico	1.54728 bushels.
Do	Morocco	Strike fanega, 70 pounds; full fanega, 118 pounds.
Do	Uruguay (double)	7.776 bushels.
Do	Uruguay (single)	3.888 bushels.
Do	Venezuela	1.599 bushels.
Fanega (liquid)	Spain	16 gallons.
Feddan	Egypt	1.03 acres.
Frail (raisins)	Spain	50 pounds.
Frasco	Argentine Republic	2.5096 quarts.
Do	Mexico	2.5 quarts.
Frasila	Zanzibar	35 pounds.
Fuder	Luxemburg	264.17 gallons.
Funt	Russia	0.9028 pound.
Garnice	Russian Poland	0.88 gallon.
Gram	Metric	15.432 grains.
Hectare	Do	2.471 acres.
Hectoliter.		
Dry	Do	2.838 bushels.
Liquid	Do	26.417 gallons.
Joch	Austria-Hungary	1.422 acres.
Ken	Japan	6 feet.
Kilogram (kilo)	Metric	2.2046 pounds.
Kilometer	Do	0.621376 mile.
Klafter	Russia	216 cubic feet.
Koku	Japan	4.9629 bushels.
Korree	Russia	3.5 bushels
Kwan	Japan	8.28 pounds.
Last	Belgium and Holland	85.134 bushels.
Do	England (dry malt)	82.52 bushels.
Do	Germany	2 metric tons (4,480 pounds).
Do	Prussia	112.29 bushels.
Do	Russian Poland	11½ bushels.
Do	Spain (salt)	4,760 pounds.
League (land)	Paraguay	4,633 acres.
Li	China	2,115 feet.
Libra (pound)	Argentine Republic	1.0127 pounds.
Do	Central America	1.043 pounds.
Do	Chile	1.014 pounds.
Do	Cuba	1.0161 pounds.
Do	Mexico	1.01465 pounds.
Do	Peru	1.0143 pounds.
Do	Portugal	1.011 pounds.
Do	Spain	1.0144 pounds.
Do	Uruguay	1.0143 pounds.
Do	Venezuela	1.0161 pounds.
Liter	Metric	1.0567 quarts.
Livre (pound)	Greece	1.1 pounds.
Do	Guiana	1.0791 pounds.
Load	England (timber)	Square, 50 cubic feet; unhewn, 40 cubic feet; inch planks, 600 superficial feet.
Manzana	Costa Rica	1⅗ acres.
Do	Nicaragua and Salvador	1.727 acres.

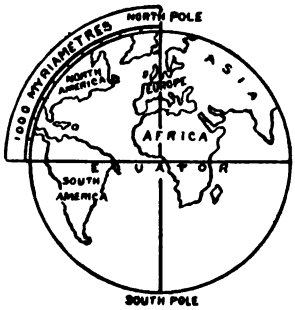
FOREIGN WEIGHTS AND MEASURES—*Continued.*

Denominations.	Where Used.	American Equivalents.
Marc	Bolivia	0.507 pound.
Maund	India	82 2/7 pounds.
Meter	Metric	39.37 inches.
Mil	Denmark	4.68 miles.
Do	Denmark (geographical)	4.61 miles.
Milla	Nicaragua and Honduras	1.1493 miles.
Morgen	Prussia	0.63 acre.
Oke	Egypt	2.7225 pounds.
Do	Greece	2.84 pounds.
Do	Hungary	3.0817 pounds.
Do	Turkey	2.82838 pounds.
Do	Hungary and Wallachia	2.5 pints.
Pic	Egypt	21 1/4 inches.
Picul	Borneo and Celebes	135.64 pounds.
Do	China, Japan, and Sumatra	133 1/3 pounds.
Do	Java	135.1 pounds.
Do	Philippine Islands	137.9 pounds.
Pie	Argentine Republic	0.9478 foot.
Do	Spain	0.91407 foot.
Pik	Turkey	27.9 inches.
Pood	Russia	36.112 pounds.
Pund (pound)	Denmark and Sweden	1.102 pounds.
Quarter	Great Britain	8.252 bushels.
Do	London (coal)	36 bushels.
Quintal	Argentine Republic	101.42 pounds.
Do	Brazil	130.06 pounds.
Do	Castile,[1] Chile, Mexico, and Peru	101.41 pounds.
Do	Greece	123.2 pounds.
Do	Newfoundland (fish)	112 pounds.
Do	Paraguay	100 pounds.
Do	Syria	125 pounds.
Do	Metric	220.46 pounds.
Rottle	Palestine	6 pounds.
Do	Syria	5 1/4 pounds.
Sagene	Russia	7 feet.
Salm	Malta	490 pounds.
Se	Japan	0.02451 acre.
Seer	India	1 pound 13 ounces.
Shaku	Japan	11.9305 inches.
Sho	Do	1.6 quarts.
Standard (St. Petersburg)	Lumber measure	165 cubic feet.
Stone	British	14 pounds.
Suerte	Uruguay	2,700 cuadras (see cuadra).
Sun	Japan	1.193 inches.
Tael	Cochin China	590.75 grains (troy).
Tan	Japan	0.25 acre.
To	Do	2 pecks.
Ton	Space measure	40 cubic feet.
Tonde (cereals)	Denmark	3.94783 bushels.
Tondeland	Do	1.36 acres.
Tsubo	Japan	6 feet square.
Tsun	China	1.41 inches.
Tunna	Sweden	4.5 bushels.
Tunnland	Sweden	1.22 acres.
Vara	Argentine Republic	34.1208 inches.
Do	Central America	32.87 inches.
Do	Chile and Peru	33.367 inches.
Do	Cuba	33.384 inches.
Do	Curacao	33.375 inches.
Do	Mexico	33 inches.
Do	Paraguay	34 inches.
Do	Spain	0.914117 yard.
Do	Venezuela	33.384 inches.
Vedro	Russia	2.707 gallons.
Vergees	Isle of Jersey	71.1 square rods.
Verst	Russia	0.663 mile.
Vlocka	Russian Poland	41.98 acres.

[1] Although the metric weights are used officially in Spain, the Castile quintal is employed in commerce in the Peninsula and colonies, save in Catalonia; the Catalan quintal equals 91.71 pounds.

DECIMAL SYSTEM—WEIGHTS AND MEASURES.

A *meter* is one ten-millionth of the distance from the equator to the North Pole.



The metric system, formed on the meter as the unit of length, has four other leading units, all connected with and dependent upon this. The *are*, the unit of surface, is the square of ten meters. The *liter*, the unit of capacity, is the cube of a tenth part of the meter. The *stere*, the unit of solidity, has the capacity of a cubic meter. The *gram*, the unit of weight, is the weight of that quantity of distilled water at its maximum density which fills the cube of a hundredth part of the meter. Each unit has its decimal multiple and submultiple, that is, weights and measures ten times larger or ten times smaller than the principal unit. The prefixes denoting the multiples are derived from the Greek, and are *deca*, ten; *hecto*, hundred; *kilo*, thousand; and *myria*, ten thousand. Those denoting sub-multiples are taken from the Latin, and are *deci*, ten; *centi*, hundred; *milli*, thousand.

Relative Value.	Length.	Surface.	Capacity.	Solidity.	Weight.
10,000	Myriameter				
1,000	Kilometer		Kiloliter		Kilogram
100	Hectometer	Hectare	Hectoliter		Hectogram
10	Decameter		Decaliter	Dekastere	Decagram
Unit	Meter	Are	Liter	Stere	Gram
0.1	Decimeter	Deciare	Deciliter	Decistere	Decigram
0.01	Centimeter	Centiare	Centiliter		Centigram
0.001	Millimeter		Milliliter		Milligram

APPROXIMATE EQUIVALENTS OF THE FRENCH (METRIC) AND ENGLISH MEASURES.

1 yard	$\frac{11}{12}$ meter.
11 meters	12 yards.
To convert meters into yards	Add $\frac{1}{11}$th.
1 meter = 1.1 yd.; 3.3 ft.	3 ft. 3$\frac{3}{8}$ inches ($\frac{1}{512}$th less). 40 inches (1.6 per cent less).
1 meter, by the Standards Commission	= 39.38203 inches.
1 meter, by the Act of 1878	= 39.37079 inches.
1 foot	3 decimeters (more exactly 3.048).
1 inch	25 millimeters (more exactly 25.4).
1 mile	1.6 or 1$\frac{3}{5}$ kilometers (more exactly 1.60931)
1 kilometer	$\frac{5}{8}$ of a mile.
1 chain (22 yards)	20 meters (more exactly 20.1165).
5 furlongs (1,100 yards)	1 kilometer (more exactly 1.0058).
1 square yard	$\frac{5}{6}$ square meter (more exactly .8361).
1 square meter	10$\frac{3}{4}$ square feet. 1$\frac{1}{5}$ square yards.
1 square inch	6$\frac{1}{2}$ square centimeters (more exactly 6.45).
1 square mile (640 acres)	260 hectares (0.4 per cent less).
1 acre (4840 square yards)	4000 square meters (1.2 per cent more).
1 cubic yard	$\frac{3}{4}$ cubic meter (2 per cent more).
1 cubic meter	1$\frac{1}{3}$ cubic yards (1$\frac{2}{3}$ per cent less).
1 cubic meter	35$\frac{1}{3}$ cubic feet (.05 per cent less).
1 cubic meter of water	1 long ton nearly.
1 kilogram	2.2 pounds fully.
1,000 kilograms 1 metric ton	1 long ton nearly.
1 long hundredweight	51 kilograms nearly.
1 United States hundredweight	45$\frac{1}{3}$ kilograms nearly.

METRIC MEASURES.

Measures.	Metric to Customary.		Customary to Metric.	
LENGTHS	1 Millimeter	= 0.03937 inch	1 Inch	= 25.4001 millimeters
	1 Centimeter	= 0.3937 "	1 "	= 2.54001 centimeters
	1 Meter	= 39.37 "	1 "	= 0.0254 meter
	1 "	= 3.28083 feet	1 Foot	= 0.304801 "
	1 "	= 1.093611 yards	1 Yard	= 0.914402 "
	1 Kilometer	= 0.62137 mile	1 Mile	= 1.60935 kilometers
AREAS	1 Square Millimeter	= 0.00155 square inch	1 Square Inch	= 645.16 square millimeters
	1 " Centimeter	= 0.1550 " "	1 " "	= 6.452 " centimeters
	1 " Meter	= 10.764 " feet	1 " Foot	= 0.0929 " meter
	1 " "	= 1.1960 " yards	1 " Yard	= 0.8361 " "
	1 " Kilometer	= 0.3861 " mile	1 " Mile	= 2.5900 " kilometers
	1 Hectare	= 2.471 acres	1 Acre	= 0.4047 hectares
VOLUMES	1 Cubic Millimeter	= 0.000061 cubic inch	1 Cubic Inch	= 16,387.2 cubic millimeters
	1 " Centimeter	= 0.0610 " "	1 " "	= 16.3872 " centimeters
	1 " Meter	= 35.314 " feet	1 " Foot	= 0.02832 " meter
	1 " "	= 1.3079 " yard	1 " Yard	= 0.7645 " "
CAPACITY. *Liquid*	1 Liter	= 1.05668 quarts	1 Quart	= 0.94636 liter
	1 "	= 0.26417 gallon	1 Gallon	= 3.78543 "
Dry	1 Liter	= 0.9081 quart	1 Quart	= 1.1012 liters
	1 "	= 0.11351 peck	1 Peck	= 8.80982 "
	1 Decaliter	= 1.1351 "	1 "	= 0.8810 decaliter
	1 Hectoliter	= 2.83774 bushels	1 Bushel	= 0.35239 hectoliter
MASSES. *Avoirdupois*	1 Gram	= 15.4324 grains	1 Grain	= 0.06480 gram
	1 "	= 0.03527 ounce	1 Ounce	= 28.3495 "
	1 Kilogram	= 2.20462 pounds	1 Pound	= 0.45359 kilogram
Troy	1 Gram	= 0.03215 ounce	1 Ounce.	= 31.10348 grams
	1 Kilogram	= 2.67923 pounds	1 Pound	= 0.37324 kilogram
Apothecaries'	1 Gram	= 0.2705 dram	1 Dram	= 3.6967 grams
	1 "	= 0.8115 scruple	1 Scruple	= 1.2322 "

FRENCH AND ENGLISH COMPOUND EQUIVALENTS.

1 kilogram per linear meter	.672 pound per linear foot. 2.016 pounds per yard.
1,000 kilograms (1 ton) per meter	.300 long ton per foot; ⅓ short ton per foot.
1 kilogram per kilometer	3.548 pounds per mile.
1,000 kilograms (1 ton) per kilometer	1.584 long tons per mile; 1.774 short tons per mile.
1 kilogram per square millimeter	1422.32 pounds per square inch; .635 long ton per square inch; .711 short ton per sq. in.
1 kilogram per square centimeter	14.2232 pounds per square inch.
1 kilogram per square decimeter	20.481 pounds per square foot.
1 kilogram per square meter	1.843 pounds per square yard.
1,000 kilograms (1 ton) per square meter	.8229 long ton, .922 short ton, per square yard.
1 kilogram per ton	2.240 pounds per long ton; 2 pounds per short ton.
1 kilogram per ton per kilometer	3.6042 pounds per long ton per mile.
1 liter of water at 4° C. per ton per kilometer.	.4325 U. S. gal. at 62° F. per long ton per mile.
1 gram per square millimeter	1.422 pounds per square inch.
1 gram per square centimeter	.01422 pound per square inch.
1 kilogram per cubic meter	.1686 pound per cubic yard. .0624 pound per cubic foot.
1,000 kilograms (1 ton) per cubic meter	.984 long ton per cubic meter. .752 ton per cubic yard.
1 cubic meter per kilogram	16.019 cubic feet per pound.
1 cubic meter per ton	1.329 cubic yards per long ton. 35.882 cubic feet per long ton.
1 cubic meter per kilometer	2.105 cubic yards per mile.
1 cubic meter per linear meter	1.196 cubic yards per linear yard.
1 cubic meter per square meter	3.281 cubic feet per square foot.
1 cubic meter per hectare	.405 cubic meter per acre. .529 cubic yard per acre.
1 kilogrammeter	7.233 foot-pounds.
1 kilogrammeter	=0.00323 foot-ton (long)=.00362 foot-ton (short).
1 ton-meter	3 foot-tons (long); 3.36 (short).
1 cheval vapeur, or cheval (75k×m per second).	.9863 horse-power.
1 kilogram per cheval	2.235 pounds per horse-power.
1 square meter per cheval	10.913 square feet per horse-power.
1 cubic meter per cheval	35.806 cubic feet per horse-power.
1 calorie, or French unit of heat	3.968 British heat-units.
French mechanical equivalent of heat (423.55k×m)	3063.5 foot-pounds.
1 calorie per square meter	.369 heat-unit per square foot.
1 calorie per kilogram	1.800 heat-units per pound.

ENGLISH AND FRENCH.

1 pound per linear foot	1.488 kilograms per linear meter.
1 pound per yard	.496 kilogram per meter.
1 long ton per foot	33.32 kilograms (3⅓ tons approx.) per meter.
1 long ton per yard	1111 kilograms (1$\frac{1}{10}$ tons approx.) per meter.
1 pound per mile	.2818 kilogram per kilometer.
1 long ton per mile	.6313 ton per kilometer.
1 pound per long ton	.4464 kilogram per ton.
1 pound per long ton per mile	.2774 kilogram per ton per kilometer.
1 pound per square inch	.0703077 kilogram per square centimeter. .7031 gram per square millimeter. 5.170 centimeters of mercury at 0° C.
1 atmosphere (14.7 pounds per square inch)	1.0335 kilograms per square centimeter.
1,000 pounds per square inch	.703077 kilogram per square millimeter.
2,000 pounds per square inch	1.406154 kilograms per square millimeter.
1 long ton per square inch	1.575 kilograms per square millimeter.
1 pound per square foot	4.883 kilograms per square meter.
1,000 pounds per square foot	4882.517 kilograms per square meter.
1 ton per square foot	10.936 tons per square meter.
1,000 pounds per square yard	542.500 kilograms per square meter.
1 ton per square yard	1.215 tons per square meter.
1 pound per cubic yard	.5933 kilogram per cubic meter.
1 pound per cubic foot	16.020 kilograms per cubic meter.
1 ton per cubic yard	1.329 tons per cubic meter.
1 cubic yard per pound	1.6855 cubic meters per kilogram.
1 cubic yard per ton	.7525 cubic meter per ton.
1 cubic yard per mile	.4750 cubic meter per kilometer.
1 cubic yard per linear yard	.836 cubic meter per linear meter.
1 cubic foot per square foot	.3048 cubic meter per square meter.
1 cubic meter per acre	2.471 cubic meters per hectare.
1 cubic yard per acre	1.889 cubic meters per hectare.
1 foot-pound	.1382 kilogrammeter.

FRENCH AND ENGLISH COMPOUND EQUIVALENTS—*Continued.*

1 foot-ton (long)	.3097 ton-meter.
1 horse-power	1.0139 cheval.
1 pound per horse-power	.447 kilogram per cheval.
1 square foot per horse-power	.0916 square meter per cheval.
1 cubic foot per horse-power	.0279 cubic meter per cheval.
1 British unit of heat, or heat-unit	.252 calorie.
British mechanical equivalent of one heat-unit (772 foot-pounds)	106.7 kilogrammeters.
1 British heat-unit per square foot	2.713 calories per square meter.
1 British heat-unit per pound	$\frac{5}{9}$ calorie per kilogram.

—D. K. Clark, Mechanical Engineer's Pocket Book.

To Reduce Parts by Volume, or Measure to Parts by Weight.—Multiply the parts by volume, or measure, by the specific gravity of the different substances: the result will be parts by weight.

MENSURATION.

SURFACES.

Parallelogram.—Area equals base multiplied by height.

Triangle.—Base and height given. Multiply base by height and divide by two.

When three sides are given. From the half sum of the three sides subtract each side separately; multiply the half sum and the three remainders together. The area is the square root of the product thus obtained.

Trapezium (a figure with two sides parallel and two sides not parallel).—To find the area multiply the sum of the two parallel sides by the distance between them and divide by two.

Square or Rhombus (an oblique parallelogram with four equal sides).—Area equals half the product of the diagonals.

Irregular Polygon.—The area may be found by dividing it into a series of triangles and trapeziums, and finding the sum of the areas thus obtained.

Regular Polygon.—Area equals number of sides multiplied by length of one side and by the radius of the inscribed circle divided by two.

Circle.—Circumference equals diameter multiplied by 3.1416, or approximately by $3\frac{1}{7}$. Area equals diameter squared multiplied by .7854.

Sector of Circle.—Multiply the length of the arc by the radius and divide by two.

Segment of Circle.—Find the area of the sector having the same arc. Also find area of triangle formed by the radial sides and the chord. The area equals the sum or difference of these according as the segment is greater or less than a semicircle.

Annulus.—Multiply the sum of the diameters by their difference and by .7854.

Square Equal to a Circle.—Side of square equals diameter multiplied by .8862.

Inscribed Square.—Side of square equals diameter multiplied by .7071.

Ellipse.—Area equals the product of the two axes by .7854.

SOLIDS.

Cube.—Surface equals length of one edge squared and multiplied by six. Contents equals length of one edge cubed.

Cylinders and Prisms.—Surface equals perimeter of one end multiplied by height plus twice the area of one end. Contents equals area of base multiplied by height. This last also applies to oblique cylinders and prisms.

Cone or Pyramid.—Surface equals circumference of base multiplied by slant height divided by two, plus the area of the base. Contents equals area of base multiplied by one-third perpendicular height. This last applies whether the cones and pyramids be right or oblique.

Frustum of Cone or Pyramid.—Contents: To the sum of the area of the two ends add the square root of their product and multiply the quantity thus obtained by one-third the perpendicular height.

Sphere.—Area equals square of diameter multiplied by 3.1416 or $3\frac{1}{7}$; *i.e.*, it is equal to four times the area of one of its great circles, or to the convex surface of its circumscribing cylinder. Surfaces of spheres vary as the squares of their diameters. Contents equal the cube of the diameter multiplied by .5236, *i.e.*, equals area of surface multiplied by diameter and divided by six. Contents of spheres vary as the cubes of the diameter.

Segment of Sphere.—Contents: From three times the diameter of the sphere subtract twice the height of the segment, multiply the difference by the square of the height and by .5236; or, another rule: Add the square of the height to three times the square of the radius of the base and multiply the sum by the height and by .5236.

Zone of Sphere.—To the sum of the squares of the radii of the two ends add one-third the square of the height, multiply the sum by the height and by 1.5708.

Cone, Sphere, and Cylinder.—The contents of a cone, sphere, and cylinder of same diameter and height are in the ratio of 1 to 2 to 3.—*Practical Engineer's Electrical Pocket Book and Diary.*

CIRCULAR MEASURE.

Diameter of a Circle × 3.1416 gives Circumference.

Diameter Squared × .7854 gives Area of Circle.

Diameter Squared × 3.1416 gives Surface of Sphere.

Diameter Cubed × .5236 gives Solidity of Sphere.

One Degree of Circumference × 57.3 gives Radius.

Diameter of Cylinder × 3.1416, and product by its length, gives the Surface.

Diameter Squared × .7854, and product by the length, gives Solid Contents.

A Circular Acre is 235.504 feet, a Circular Rood 117.752 feet, in diameter. The Circumference of the globe is about 24,855 miles, and the Diameter about 7,900 miles.—*Whittaker's Almanac.*

ANGULAR MEASURE.

There is perfect unanimity as to the standard angle (i.e., the right angle) and practical unanimity as to its subdivision, for the subdivision into grades, etc., once favored by the French, is now abandoned.

1 minute of angle or arc	= 60 seconds.
1 degree " " " "	= 60 minutes.
90 degrees " " " "	= 1 right angle or ¼ of circumference.
Radian " " " "	= arc same length as radius.
" " " " "	= 57.295779513082°.
Length of arc of 1°	= 0.017453292520.
Length of arc of 1′	= 0.000290888209.
" " " " 1″	= 0.015707963268.

TIME.

The unit of time measurement is the same among all nations. Practically it is $\frac{1}{86400}$ of the mean solar day, but really it is a perfectly arbitrary unit, as the length of the mean solar day is not constant for any two periods of time. There is no constant natural unit of time.

1 minute	= 60 seconds.
1 hour	= 60 minutes, 3600 seconds.
1 day	= 24 hours, 1440 minutes, 86,400 seconds.
1 sidereal day	= 86164.1 seconds.
1 sidereal month	= 27.321661 mean solar days (average).
1 lunar month	= 29.530589 mean solar days (average).
1 anomalistic month	= 27.544600 mean solar days (average).
1 tropical month	= 27.321582 mean solar days (average).
1 nodical month	= 27.212222 mean solar days (average).
Mean solar year	= 365 d. 5 h. 48 m. 46.045 s. with annual variation of 0.00539.

The change in the length of the mean sidereal day, i.e., of the time of the earth's rotation upon its axis, amounts to 0.01252 s. in 2400 mean solar years.

—*Physical Tables.*

TABLE OF DECIMAL EQUIVALENTS OF FRACTIONS OF AN INCH.

1/64	=	·015625	11/32	=	·34375	43/64	=	·671875
1/32	=	·03125	23/64	=	·359375	11/16	=	·6875
3/64	=	·046875	3/8	=	·375	45/64	=	·703125
1/16	=	·0625	25/64	=	·390625	23/32	=	·71875
5/64	=	·078125	13/32	=	·40625	47/64	=	·734375
3/32	=	·09375	27/64	=	·421875	3/4	=	·75
7/64	=	·109375	7/16	=	·4375	49/64	=	·765625
1/8	=	·125	29/64	=	·453125	25/32	=	·78125
9/64	=	·140625	15/32	=	·46875	51/64	=	·796875
5/32	=	·15625	31/64	=	·484375	13/16	=	·8125
11/64	=	·171875	1/2	=	·50	53/64	=	·828125
3/16	=	·1875	33/64	=	·515625	27/32	=	·84375
13/64	=	·203125	17/32	=	·53125	55/64	=	·859375
7/32	=	·21875	35/64	=	·546875	7/8	=	·875
15/64	=	·234375	9/16	=	·5625	57/64	=	·890625
1/4	=	·25	37/64	=	·578125	29/32	=	·90625
17/64	=	·265625	19/32	=	·59375	59/64	=	·921875
9/32	=	·28125	39/64	=	·609475	15/16	=	·9375
19/64	=	·296875	5/8	=	·625	61/64	=	·953125
5/16	=	·3125	41/64	=	·640625	31/32	=	·96875
21/64	=	·328125	21/32	=	·65625	63/64	=	·984375

WEIGHTS AND MEASURES OF THE BIBLE.

WEIGHTS.

	Avoirdupois.				Troy.			
	Lbs.	Oz.	Drs.		Lbs.	Oz.	Dwt.	Gr.
A gerah	0	0	0.439	=	0	0	0	12
10 gerahs = 1 bekah	0	0	4.39	=	0	0	5	0
2 bekahs = 1 shekel	0	0	8.78	=	0	0	10	0
60 shekels = 1 maneh	2	0	14.628	=	2	6	0	0
50 manehs = 1 talent	102	13	11.428	=	125	0	0	0

MEASURES.

Long Measure.	Ft.	In.
A digit, or finger (Jer. lii. 21)	0	0.912
4 digits = 1 palm (Exod. xxv. 25)	0	3.648
3 palms = 1 span (Exod. xxviii. 16)	0	10.944
2 spans = 1 cubit (Gen. vi. 15)	1	9.888
4 cubits = 1 fathom (Acts xxvii. 28)	7	3.552
1.5 fathoms = 1 reed (Ezek. xl. 3, 5)	10	11.328
13.3 reeds = 1 line (Ezek. xl. 3)	145	11.04

Land Measure.	Eng. miles.	Paces.	Ft.
A cubit	0	0	1.824
400 cubits = 1 furlong (Luke xxiv. 13)	0	145	4.6
5 furlongs = 1 sabbath day's journey (John xi. 18; Acts i. 12)	0	727	3.0
10 furlongs = 1 mile (Matt. v. 41)	1	399	1.0
24 miles = 1 day's journey	33	76	4.0

Liquid Measure.	Gals.	Pts.
A caph	0	0.625
1.3 caphs = 1 log (Lev. xiv. 10)	0	0.833
4 logs = 1 cab	0	3.333
3 cabs = 1 hin (Exod. xxx. 24)	1	2
2 hins = 1 seah	2	4
3 seahs = 1 bath, or ephah (1 Kings vii. 26; John ii. 6)	7	4.5
10 ephahs = 1 kor, or homer (Isa. v. 10; Ezek. xiv. 14)	75	5.25

WEIGHTS AND MEASURES OF THE BIBLE—*Continued.*

Dry Measure.	Pecks.	Gals.	Pts.
A gachal	0	0	0.1416
20 gachals = 1 cab (2 Kings vi. 25; Rev. vi. 6)	0	0	2.8333
1.8 cabs = 1 omer (Exod. xvi. 36)	0	0	5.1
3.3 omers = 1 seah (Matt. xiii. 33)	1	0	1
3 seahs = 1 ephah (Ezek. xlv. 11)	3	0	3
5 ephahs = 1 letech (Hosea iii. 2)	16	0	0
2 letechs = 1 kor, or homer (Num. xi. 32; Hos. iii. 2)	32	0	0

N.B.—The above Table will explain many texts in the Bible. Take, for instance, Isa. v. 10· "Yea, ten acres of vineyard shall yield one bath, and the seed of an homer shall yield an ephah." This curse upon the covetous man was, that 10 acres of vines should produce only 7 gallons of wine, i.e., one acre should yield less that 3 quarts; and that 32 pecks of seed should only bring a crop of 3 pecks, or, in other words, that the harvest reaped should produce but one-tenth of the seed sown.

TIME.

The *Natural* Day was from sun-rise to sun-set.
The *Natural* Night was from sun-set to sun-rise.
The *Civil* Day was from sun-set one evening to sun-set the next; for, "the Evening and the Morning were the first day."

NIGHT (*Ancient*).

First Watch (Lam. ii. 19) till midnight.
Middle Watch (Judg. vii. 19) till 3 a.m.
Morning Watch (Exod. xiv. 24) till 6 a.m.

NIGHT (*New Testament*).

First Watch, *evening* = 6 to 9 p.m.
Second Watch, *midnight* = 9 to 12 p.m.
Third Watch, *cock-crow* = 12 to 3 a.m.
Fourth Watch, *morning* = 3 to 6 a.m.

DAY (*Ancient*).

Morning till about 10 a.m.
Heat of day till about 2 p.m.
Cool of day till about 6 p.m.

DAY (*New Testament*).

Third hour = 6 to 9 a.m.
Sixth hour = 9 to 12 midday.
Ninth hour = 12 to 3 p m.
Twelfth hour = 3 to 6 p.m.

JEWISH MONEY.

With its value in English and American money; the American dollar being taken as equal to 4s. 2d.

Jewish.		English. £	s.	d.		American. Dols.	Cents.
A gerah (Exod. xxx. 13)	=	0	0	1.36	=	0	2.73
10 gerahs = 1 bekah (Exod. xxxviii. 26)	=	0	1	1.68	=	0	27.37
2 bekahs = 1 shekel (Exod. xxx. 13; Isa. vii. 23)	=	0	2	3.37	=	0	54.74
50 shekels = 1 maneh	=	5	14	0.75	=	27	37.50
60 manehs = 1 kikkar (talent)	=	342	3	9	=	1,642	50
A *gold* shekel	=	1	16	6	=	8	76
A kikkar of gold	=	5,475	0	0	=	26,280	0

N.B.—A *shekel* would probably purchase nearly ten times as much as the same nominal amount will now. Remember that one *Roman* penny (8½*d.*) was a good day's wages for a laborer.

The Hebrew *maneh*, according to 1 Kings x. 17, compared with 2 Chron. ix. 16, contained 100 shekels; though according to one interpretation of Ezek. xlv. 12, it contained 60, but more probably 50. The passage reads thus:—"Twenty shekels, five and twenty shekels fifteen shekels shall be your maneh." This is variously interpreted, (1) 20+25+15 = 60. (2) 20, 25, 15 are different coins in gold, silver, and copper, bearing the same name. It is well to remark the meaning of these names: Shekel = simply *weight:* Bekah = *split*, i.e., the shekel divided into two: Gerah = a *grain*, as in our weights, a grain and a *barley-corn*, the original standard weight: Maneh = *appointed*, equivalent to *sterling*, a specific sum: Kikkar = a *round* mass of metal, i.e., a weight or coin. Hebrew names of weights and coins are not found in the New Testament: *mna* in Luke xix. 13 is Greek, though possibly identical with the Hebrew *maneh*.

ROMAN MONEY.

Roman.	English. d.		American. Cents.
A "farthing," *quadrans* (Matt. v. 26) = nearly	0.125	=	0.25
A "farthing," *as* = 4 *quadrantes* (Matt. x. 29) = nearly	0.5	=	1
A "penny," *denarius* = 16 *asses* (Matt. xxii. 19) = nearly	8.50	=	17

[The Roman sestertius = 2½ asses, is not named in the Bible.]

N.B.—Here we learn that—

NAAMAN's offering to Elisha of 6,000 pieces (shekels) of gold amounted to more than £10,000 = 48,000 *dollars*.

The DEBTOR (Matt. xviii. 24) who had been forgiven 10,000 talents, i.e., £3,000,000 = 14,400,000 *dollars*, refused to forgive his fellow-servant 100 pence, i.e., £3 10*s*. 10*d* = 17 *dollars*.

JUDAS sold our Lord for 30 pieces of silver, i.e., £3 10*s*. 8*d*. = 16 *dollars* 96 *cents*, the legal value of a slave, if he were killed by a beast.

JOSEPH was sold by his brethren for 20 pieces, i.e. £2 7*s*. = 11 *dollars* 28 *cents*.

—*Oxford University Bible.*

TIME AND WATCH ON BOARD SHIP.

WATCH.—For purposes of discipline, and to divide the work fairly, the crew is mustered in two divisions: the Starboard (right side, looking forward) and the Port (left). The day commences at noon, and is thus divided:—

Afternoon *Watch*	....	noon to 4 p.m.
First Dog "	....	4 p.m. to 6 p.m.
Second Dog "	....	6 p.m. to 8 p.m.
First "	....	8 p.m. to midnight.
Middle "	....	12 p.m. to 4 a.m.
Morning "	....	4 a.m. to 8 a.m.
Forenoon "	....	8 a.m. to noon.

This makes seven WATCHES, which enables the crew to keep them alternately, as the *Watch* which is on duty in the forenoon one day has the afternoon next day, and the men who have only four hours' rest one night have eight hours the next. This is the reason for having *Dog Watches*, which are made by dividing the hours between 4 p.m. and 8 p.m. into two *Watches*.

TIME.—Time is kept by means of "Bells," although there is but one bell on the ship, and to strike the clapper properly against the bell requires some skill.

First, two strokes of the clapper at the interval of a second, then an interval of two seconds; then two more strokes with a second's interval apart, then a rest of two seconds, thus:—

BELL, ONE SECOND; B., TWO SECS.: B. s.; B. ss; B. s.; B. ss.; B.

1 Bell is struck at 12.30, and again at 4.30, 6.30, 8.30 p.m.; 12.30, 4.30, and 8.30 a.m.

2 Bells at 1 (struck with an interval of a second between each—B. s, B.), the same again at 5, 7, and 9 p.m.; 1, 5, and 9 a.m.

3 Bells at 1.30 (B. s, B. ss, B.), 5.30, 7.30, and 9.30 p.m.; 1.30, 5.30, and 9.30 a.m.

4 Bells at 2 (B. s, B. ss, B. s, B.), 6 and 10 p.m.; 2, 6, and 10 a.m.

5 Bells at 2.30 (B. s, B ss, B. s, B. ss, B.) and 10.30 p.m.; 2.30, 6.30, and 10.30 a.m.

6 Bells at 3 (B. s, B. ss, B. s, B. ss, B. s, B.) and 11 p.m.; 3, 7, and 11 a.m.

7 Bells at 3.30 (B. s, B. ss, B. s, B. ss, B. s, B. ss, B.) and 11.30 p.m.; 3.30, 7.30, and 11.30 a.m.

8 Bells (B. s, B. ss, B. s, B. ss, B. s, B. ss, B. s, B.) every 4 hours, at noon, at 4 p.m., 8 p.m., midnight, 4 a.m., and 8 a.m.

—*Whittaker's Almanac.*

STONES: SPECIFIC GRAVITY, WEIGHT AND VOLUME.

STONES.	Specific Gravity.	Weight of one Cubic Foot.	Cubic Feet per Ton.
	Water = 1.	Pounds.	Cubic Ft.
Alabaster, calcareous	2.76	172.1	13.0
" gypseous	2.31	144.0	15.6
Barytes	4.45	277.5	8.07
Basalt	2.45–3.00	152.8–187.1	14.7–12.0
Chalk, air-dried	2.78	155	14.5
Diamond	3.50	....	....
Flint	2.59	164	13.7
Felspar	2.60	162.1	13.8
Gneiss	2.69	168	13.3
Granite	2.50–2.74	156–171	14.4–13.1
Graphite	2.20	137.2	16.3
Jasper	2.72	169.7	13.2
Limestone	1.86–2.53	116–158	19.3–14.2
Marble:			
African	2.80	174.6	12.8
British	2.71	169.0	13.3
Carrara	2.72	169.6	13.2
Egyptian green	2.67	166.5	13.5
Florentine	2.52	157.1	14.3
French	2.65	165.2	13.6
Mica	2.93	183	12.2
Oolitic stones	1.89–2.60	118–162	19.0–13.8
Ores:			
Spicular or red iron ore	5.21	327.4	6.84
Magnetic iron ore	5.09	317.6	7.05
Brown iron ore	3.92	244.6	9.16
Spathic iron ore	3.83	238.8	9.38
Quartz	2.61–2.71	162.8–169	13.8–13.3
Sandstone	2.04–2.70	127–168	17.6–13.3
Serpentine	2.81	175.2	12.8
Slate	2.60–2.85	162.1–177.7	13.8–12.6
Talc, steatite	2.70	168.4	13.3

MINERAL SUBSTANCES, VARIOUS: SPECIFIC GRAVITY, WEIGHT, AND VOLUME.

Substances.	Specific Gravity.	Weight of One Cubic Foot.	Cubic Feet per Ton
	Water = 1.	Pounds.	Cubic Ft.
Alum	1.72	107.2	20.9
Ballast (brick rubbish and gravel)	1.80	112	20.0
Brick	1.90–2.40	124.7–135.3	18.1–16.0
Brickwork	1.76–1.84	110	20.4–18
Camphor	.99	61.7	36.3
Clay	1.92	119.7	18.7
Coal:			
Anthracite	1.37–1.59	85.4–99.1	26.2–22.6
Bituminous	1.20–1.31	74.8–81.7	30–28.1
Earth, argillaceous:	....	93–137	16–24
Dry, loose	1.15–1.29	72–80	31.1–28
Dry, shaken	1.32–1.48	82–92	27.3–24.3
Moist, loose	1.06–1.22	66–76	34.0–29.5
Packed	1.44–1.60	90–100	24.8–22.4
Glass:			
Flint	2.90	187.0	12.0
Green	2.70	168.4	13.3
Plate	2.70	168.4	13.3
Thick flooring	2.53	158.0	14.2
Crown	2.50	155.9	14 4
Gunpowder, heaped	1.75–1.84	109.1–114.7	20.5–19.5
Ice, melting	.922	57.5	39
Marl	1.60–1.90	99.8–118.5	22.4–18.9
Masonry:			
Ashlar granite	2.37	147.5	15.2
" Limestone, hard	2.70	168.5	11.4
" " semi-hard	2.42	151.9	14.8
" " soft	2.34	145.6	15.4
" Sandstone	2.61	162.5	13.2
Rubble, dry	2.21	138	16.2
" mortar	2.47	154	14.6
Mortar, hardened	1.65	103	21.7
Mud:			
Dry, close	1.28–1.93	80–110	28.0–20.4
Wet, moderately pressed	1.93–2.09	110–130	20.4–17.2
Wet, fluid	1.67–1.92	104–120	21.5–18.7
Phosphorus	1.77	110.4	20.3
Plaster	1.87–2.47	98	22.9
Portland cement	1.25–1.51	78–94	28.7–23.8
Potash	2.10	131	17.1
Sand	1.44–1.87	90–117	24.9–19.1
" saturated with water	1.89–2.07	118–129	19–17.4
Salt, common	1.92	119.7	18.7
" rock	2.10–2.26	131–140.7	17.1–15.9
Sulphur	2.00	124.7	18.0
Tiles	2.00	124.7	18.0

FUELS, ETC.: SPECIFIC GRAVITY, WEIGHT, AND BULK.

Fuels.	Specific Gravity.	Weight of One Cubic Foot.		Volume of One Ton, Heaped.
		Solid.	Heaped.	
Coals.	Water = 1.	Lbs.	Lbs.	Cub. Ft.
Anthracite, American	1.30–1.84	93.5	54.0	....
Bituminous coal, American	1.27	84.0	50.0	....
Coke.				
Coke, generally	....	40–50	30.0	70–80
American	....	....	32.1	69.8
Graphite	2.33	145.3	....	....
Lignite and Asphalt.				
Perfect lignite	1.29	....	....	....
Imperfect lignite	1.15	....	....	....
Bituminous lignite	1.18	....	....	....
Asphalt	1.06	....	....	....
Wood Charcoal.				
As made, heaped.	Heaped.			
Oak and beech	.24–.25	....	15–15.6	....
Birch	.22–.23	....	13.7–14.3	....
Pine	.20–.21	....	12.5–13.1	....
Average	.225	....	14	....
Gunpowder, loose	.90	....	....	....
" shaken	1.00	....	....	....
" solid	1.55–1.80	....	....	....

WOODS: SPECIFIC GRAVITY AND WEIGHT.

Wood.	Specific Gravity.	Weight of One Cubic Foot.
	Water = 1.	Pounds.
Ash	.84	52.4
" with 20 per cent. moisture	.70	43.7
Apple tree	.79	45.5
Bamboo	.31–.40	19.5–24.9
Beech	.75–.85	46.8–50.3
" with 20 per cent. moisture	.82	51.1
" cut one year	.66	41.2
Birch	.72–.74	44.9–46.1
Boxwood	1.04	64.8
Cedar of Lebanon	.49–.57	30.6–35.5
Cork	.24	15.0
Cypress, cut one year	.66	41.2
Ebony	1.13	70.5
Elder pith	.076	4.74
Elm	.55–.67	34.3
" Green	.76	47.5
" with 20 per cent. moisture	.72	44.9
Fir, Norway Pine	.74	46.1
" Spruce	.48–.70	29.9–43.7
" Larch	.50–.64	31.2–39.9
" White Pine, Scotch	.53	34.3
" " " " with 20 per cent. moisture	.49	30.6
" Yellow Pine, American	.46	28.7
" " " English	.66	41.2
Lignum-Vitæ	.65–1.33	40.5–82.9
Mahogany, Cuba	.56–1.06	34.9
" Honduras	.56–1.06	34.9
Maple	.65–.73	40.5
" 20 per cent. moisture	.67	41.8
Mulberry	.89	55.5
Oak, American	.87	54.2
Poplar	.39	24.3
" White	.32–.51	20.0–31.8
" 20 per cent. moisture	.48	29.9
Rock-Elm	.80	50.0
Sycamore	.59	36.8
Walnut	.58	42.4
Willow	.49	30.6

ANIMAL SUBSTANCES: SPECIFIC GRAVITY AND WEIGHT. (Claudel.)

SUBSTANCE.	Specific Gravity.	Weight of One Cu. Ft.
	Water = 1.	Pounds.
Pearls	2.72	169.6
Coral	2.69	167.7
Ivory	1.82–1.92	114–119.7
Bone	1.80–2.00	112.2–124.7
Wool	1.61	100.4
Tendon	1.12	69.8
Cartilage	1.09	68.0
Human Body	1.07	66.7
Nerve	1.04	64.9
Beeswax	.96	59.9
Lard	.95	59.3
Spermaceti	.94	58.8
White of Whalebone	.94	58.7
Butter	.94	58.7
Pork Fat	.94	58.7
Tallow	.92	57.5
Beef Fat	.92	57.5
Mutton Fat	.92	57.4
VEGETABLE SUBSTANCES:—		
Cotton	1.95	121.6
Flax	1.79	111.6
Starch	1.53	95.4
Sugar	1.005	....
Gutta-percha	.97	60.5
India-rubber	.93	58.0
	Weight of One Cu. Ft., loosely filled.	Weight of One Cu. Ft., closely filled.
Grain:		
Wheat, California	49	53
Peas	50	54
Indian Corn	43½	47

LIQUIDS: SPECIFIC GRAVITY AND WEIGHT.

LIQUIDS AT 32° F.	Specific Gravity.	Weight of One Cubic Foot.	Weight of One Gallon.
	Water = 1.	Pounds.	Pounds.
Mercury	13.596	848.7	136.0
Sulphuric Acid, maximum concentration	1.84	114.9	18.4
Nitrous Acid	1.55	96.8	15.5
Chloroform	1.53	95.5	15.3
Nitric acid, of commerce	1.22	76.2	12.2
Acetic acid, maximum concentration	1.08	67.4	10.8
Milk	1.03	64.3	10.3
Sea Water, ordinary	1.026	64.05	10.3
Pure Water, at 39° F.	1.000	62.425	10.0112
Wine, Red	.99	62.0	9.9
Oil, Linseed	.94	58.7	9.4
" Rapeseed	.92	57.4	9.2
" Whale	.92	57.4	9.2
" Olive	.915	57.1	9.15
" Turpentine	.87	54.3	8.7
Tar	1.00	62.4	10.0
Petroleum	.88	54.9	8.8
Naphtha	.85	53.1	8.5
Ether, Nitric	1.11	69.3	11.1
" Sulphurous	1.08	67.4	10.8
" Nitrous	.89	55.6	8.9
" Acetic	.89	55.6	8.9
" Hydrochloric	.87	54.3	8.7
" Sulphuric	.74	44.9	7.2
Alcohol, proof spirit	.92	57.4	9.2
" pure	.79	49.3	7.9
Benzine	.85	53.1	8.5
Proof Spirit	.80	49.9	8.0

GASES AND VAPORS: SPECIFIC GRAVITY, WEIGHT, AND VOLUME.

Gases at 32° F., and under one Atmosphere of Pressure.	Specific Gravity.	Weight of One Cubic Foot.		Volume of One Pound Weight.
	Air = 1.	Pounds.	Ounces.	Cub. Ft.
Mercury	6.9740	.563	9.008	1.776
Chloroform	5.3000	.428	6.846	2.337
Turpentine	4.6978	.378	6.042	2.637
Acetic Ether	3.0400	.245	3.927	4.075
Benzine	2.6943	.217	3.480	4.598
Sulphuric Ether	2.5860	.209	3.340	4.790
Chlorine	2.4400	.197	3.152	5.077
Sulphurous Acid	2.2470	.1814	2.902	5.513
Alcohol	1.6130	.1302	2.083	7.679
Carbonic Acid	1.5290	.12344	1.975	8.101
Oxygen	1.1056	.089253	1.428	11.205
Air	1.0000	.080728	1.29165	12.387
Nitrogen	.9701	.078596	1.258	12.723
Carbonic Oxide	.9674	.0781	1.250	12.804
Olefiant Gas	.9847	.0795	1.272	12.580
Ammoniacal Gas	.5894	.04758	7.613	21.017
Light Carbureted Hydrogen	.5527	.04462	.7139	22.412
Coal Gas	.4381	.03536	..5658	28.279
Hydrogen	.0692	.005592	.0895	178.83

WEIGHT AND VOLUME OF BODIES.
(Tod.)

Bodies.	Weight of One Cubic Foot.		Weight of One Cubic Inch.	Cubic Inches in One Pound.
Metals.	Oz.	Lb.	Oz.	Cub. In.
Antimony, cast	6,702	418.8750	3.8748	3.8866
Zinc, cast	7,190	449.3750	4.1608	3.8431
Iron, cast	7,207	450.4375	4.1707	3.8364
Tin, cast	7,291	455.6875	4.2193	3.7920
" hardened	7,299	456.1875	4.2239	3.7878
Pewter	7,471	466.9375	4.3234	3.7007
Iron, bar	7,788	486.7500	4.5069	3.5500
Cobalt, cast	7,811	488.1875	4.5202	3.5396
Steel, hard	7,816	488.5000	4.5231	3.5373
" soft meteoric	7,833	489.5625	4.5329	3.5296
Iron, hammered	7,965	497.8125	4.6093	3.4792
Nickel, cast	8,279	517.4375	4.7910	3.3395
Brass, cast	8,395	524.6875	4.8582	3.2933
" wire	8,544	534.0000	4.9444	3.2359
Nickel, hammered	8,666	541.6250	5.0150	3.1903
Gun-metal	8,784	549.0000	5.0833	3.1476
Copper, cast	8,788	549.2500	5.0856	3.1461
" wire	8,878	554.8750	5.1377	3.1140
" coin	8,915	557.1875	5.1591	3.0959
Bismuth, cast	9,822	613.8750	5.6840	2.8149
Silver, hammered	10,510	656.8750	6.0821	2.6306
" coin	10,534	658.3750	6.0960	2.6246
" pure, cast	10,744	671.5000	6.2175	2.5733
Rhodium	11,000	687.5000	6.3657	2.5134
Lead, cast	11,352	709.5000	6.3694	2.4355
Palladium	11,800	737.5000	6.8287	2.5134
Mercury (quicksilver) common	13,568	848.0000	7.8518	2.0377
" " pure	14,000	875.0000	8.1018	1.9748
Gold, trinket	15,709	981.8125	9.0908	1.7600
" coin	17,647	1,102.9375	10.2123	1.6124
" pure, cast	19,258	1,203.6250	11.1446	1.4356
" hammered	19,316	1,210.0625	11.2042	1.4280
Platinum, pure	19,500	1,218.7500	11.2847	1.4178
" hammered	20,336	1,271.0000	11.7685	1.3595
" wire	21,041	1,315.0625	12.1765	1.3140
" laminated	22,069	1,379.3125	12.7714	1.2528
Iridium, hammered	23,000	1,437.5000	13.3101	1.2021

—Clark's Mechanical Engineer's Pocket Book.

SPECIFIC GRAVITY.

Tables showing a comparison of the degrees of Baumé, Cartier, and Beck's Areometers, with specific gravity degrees.

For Liquids Lighter than Water.

Degrees of Baumé, Cartier, Beck.	Baumé. Sp. Gr.	Cartier. Sp. Gr.	Beck. Sp. Gr.
0	....	....	1.0000
1	....	....	0.9941
2	....	....	0.9883
3	....	....	0.9826
4	....	....	0.9770
5	....	....	0.9714
6	....	....	0.9659
7	....	....	0.9604
8	....	....	0.9550
9	....	....	0.9497
10	1.000	....	0.9444
11	0.993	1.000	0.9392
12	0.986	0.992	0.9340
13	0.979	0.985	0.9289
14	0.973	0.977	0.9239
15	0.967	0.969	0.9189
16	0.960	0.962	0.9139
17	0.954	0.955	0.9090
18	0.948	0.948	0.9042
19	0.942	0.941	0.8994
20	0.935	0.934	0.8947
21	0.929	0.927	0.8900
22	0.924	0.920	0.8854
23	0.918	0.914	0.8808
24	0.912	0.908	0.8762
25	0.906	0.901	0.8717
26	0.901	0.895	0.8673
27	0.895	0.889	0.8629
28	0.889	0.883	0.8585
29	0.884	0.877	0.8542
30	0.879	0.871	0.8500
31	0.873	0.865	0.8457
32	0.868	0.859	0.8415
33	0.863	0.853	0.8374
34	0.858	0.848	0.8333
35	0.853	0.842	0.8292
36	0.848	0.837	0.8252
37	0.843	0.831	0.8212
38	0.838	0.826	0.8173
39	0.833	0.820	0.8133
40	0.829	0.815	0.8095
41	0.824	0.810	0.8061
42	0.819	0.805	0.8018
43	0.815	0.800	0.7981
44	0.810	....	0.7944
45	0.806	....	0.7907
46	0.801	....	0.7871
47	0.797	....	0.7834
48	0.792	....	0.7799
49	0.788	....	0.7763
50	0.784	....	0.7727
51	0.781	....	0.7692
52	0.776	....	0.7658
53	0.771	....	0.7623
54	0.769	....	0.7589
55	0.763	....	0.7556
56	0.759	....	0.7522
57	0.755	....	0.7489
58	0.751	....	0.7456
59	0.748	....	0.7423
60	0.744	....	0.7391
61	0.740	....	0.7359
62	0.736	....	0.7328

For Liquids Heavier than Water.

Degrees of Baumé, Beck.	Baumé. Sp. Gr.	Beck. Sp. Gr.
0	1.000	1.0000
1	1.007	1.0059
2	1.014	1.0119
3	1.020	1.0180
4	1.028	1.0241
5	1.034	1.0303
6	1.041	1.0366
7	1.049	1.0429
8	1.057	1.0494
9	1.064	1.0559
10	1.072	1.0625
11	1.080	1.0692
12	1.088	1.0759
13	1.096	1.0828
14	1.104	1.0897
15	1.113	1.0968
16	1.121	1.1039
17	1.130	1.1111
18	1.138	1.1184
19	1.147	1.1258
20	1.157	1.1333
21	1.166	1.1409
22	1.176	1.1486
23	1.185	1.1565
24	1.195	1.1644
25	1.205	1.1724
26	1.215	1.1806
27	1.225	1.1888
28	1.235	1.1972
29	1.245	1.2057
30	1.256	1.2143
31	1.267	1.2230
32	1.278	1.2319
33	1.289	1.2409
34	1.300	1.2500
35	1.312	1.2593
36	1.324	1.2680
37	1.337	1.2782
38	1.349	1.2879
39	1.361	1.2977
40	1.375	1.3077
41	1.388	1.3178
42	1.401	1.3281
43	1.414	1.3386
44	1.428	1.3492
45	1.442	1.3600
46	1.456	1.3710
47	1.470	1.3821
48	1.485	1.3934
49	1.500	1.4050
50	1.515	1.4167
51	1.531	1.4286
52	1.546	1.4407
53	1.562	1.4530
54	1.578	1.4655
55	1.596	1.4783
56	1.615	1.4912
57	1.634	1.5044
58	1.653	1.5179
59	1.671	1.5315
60	1.690	1.5454
61	1.709	1.5596
62	1.729	1.5741
63	1.750	1.5888
64	1.771	1.6038

UNITS OF LOG MEASURE.

In the United States and Canada logs are most commonly measured in board feet. Firewood and wood cut into short bolts, such as small pulpwood, excelsior wood, etc., are usually measured in cords. In the Adirondack Mountains the 19-inch standard, or, as it is often called, "the market," is a common unit of log measure. In some localities a log 22 inches in diameter at the small end and 13 feet long is used as a standard log and is the unit for buying and selling timber. In other sections standards are used which are based on logs 12 feet long and respectively 21, 22, and 24 inches in diameter at the small end inside the bark.

In some cases logs are measured in cubic feet. This is common with long spar timber and with long logs to be cut or hewn square. In many localities timber is sold by the log or tree, and in some sections standing timber is sold for a specified amount per acre or other unit of land measure. Piles and mine props are usually sold by the piece or by the linear foot. Logs are occasionally sold by the ton.

BOARD MEASURE.

The unit of board measure is the board foot, which is the contents of a board 1 foot square and 1 inch thick. The number of board feet which can be sawed from logs of different diameters and lengths is shown in log rules.

Logs are usually measured at the small end inside the bark, because the removal of the slabs reduces the logs to the dimensions of the small end. This is the custom in measuring short logs by all the rules which are used, except in certain cases. Some of the rules, for example the Doyle and the Partridge rules, were intended by their originators to be used for an average diameter, but most persons who use them take the diameter at the small end, except in case of long timber. In measuring long logs which are to be cut into short logs before being sawed into boards, the diameter is usually not taken at the small end alone. Thus in using the Maine Rule, long logs are sealed as two logs. The diameter at the small end inside the bark is measured and is taken as the diameter of the uppermost log. The diameter at the small end of the lower log is estimated by the log-scaler. Another method of measuring long logs, often used with the Doyle Rule, is to take the diameters at both ends inside the bark, average them, and use this average as the diameter of the log. Still another method in use is to take the diameter inside the bark, one-third the distance from the small end of the log.

Logs are usually cut from 2 to 6 inches longer than the standard lengths of boards, to allow for bruising in handling. This additional length is disregarded in scaling.

Log rules give the number of board feet in logs which are straight and sound. If logs are unsound or otherwise defective, a certain allowance must be made by the scaler. The determination of the amount in board feet which should be deducted for unsoundness or defects in a given log requires great skill on the part of the scaler, and, as it is a matter of judgment in each case, no definite directions can be given.

CORD MEASURE.

Firewood, small pulpwood, and material cut into short sticks for excelsior, etc., is usually measured by the cord. A cord is 128 cubic feet of stacked wood. The wood is usually cut into 4-foot lengths, in which case a cord is a stack 4 feet high and 8 feet long. Sometimes, however, pulpwood is cut 5 feet long, and a stack of it 4 feet high and 8 feet long is considered 1 cord. In this case the cord contains 160 cubic feet of stacked wood. In localities where firewood is cut in 5-foot lengths a cord makes a stack 4 feet high and 6½ feet long, and contains 130 cubic feet of stacked wood. Where it is desirable to use shorter lengths for special purposes, the sticks are often cut 1½, 2, and even 3 feet long. A stack of such wood, 4 feet high and 8 feet long, is considered 1 cord, but the price is always made to conform to the shortness of the measure.

A cord foot is one-eighth of a cord. A cord foot is a stack of 4-foot wood 4 feet high and 1 foot long. Farmers frequently speak of a foot of cord wood, meaning a cord foot. By the expression "surface foot" is meant the number of square feet measured on the side of a stack.

In some localities, particularly in New England, cord wood is measured by means of calipers. Instead of stacking the wood and computing the cords in the ordinary way, the average diameter of each log is determined with calipers and the number of cords obtained by consulting a table which gives the amount of wood in logs of different diameters and lengths, expressed in so-called cylindrical feet. A cylindrical foot is one one-hundred and twenty-eighth of a cord. A better term would be "stacked cubic foot," as it represents a cubic foot of stacked wood, as opposed to a cubic foot of solid wood. The number of cylindrical or stacked cubic feet in a log is computed by squaring the average diameter of the log in inches, multiplying by the length of the log in feet, and dividing the result by 144.

Some tables give the results in feet and inches (cylindrical or stacked cubic, not linear feet).

A special caliper rule for measuring cord wood has been made by Mr. John Humphrey, of Keene, N. H. Instead of considering a cylindrical or stacked cubic foot equivalent to one one-hundred and twenty-eighth of a cord, he has assumed it to be equivalent to one one-hundredth of a cord. In either case the cylindrical or stacked cubic foot is a purely arbitrary unit and the final results in cords are the same.

The number of cylindrical or stacked cubic feet in the different logs is determined by means of calipers and reference to a table, or by means of the calipers alone if the results are inscribed directly upon them. The total number of cylindrical or stacked cubic feet is then divided by 128.

CONVERSION OF CORD MEASURE INTO CUBIC MEASURE.

Dealers in wood frequently wish to convert cord measure into cubic measure, and vice versa. The converting factor used depends primarily on the form of the wood. If the wood is split, there is more solid contents in a stacked cord than if the wood is in

round sticks. There is more wood in a given stack if the sticks are smooth and straight than if they are rough and crooked. The converting factor depends, further, on the character of the stacking. If the wood is skillfully stacked there is more solid contents than when the work is poorly done. It has been found in Europe through a series of careful measurements that a stack of wood may be reduced to solid cubic measure by multiplying the number of cubic feet by the following factors:

For split firewood. 0.7
For small round firewood. 6

Thus, a cord of split firewood is equivalent to 128 cubic feet multiplied by 0.7, which equals 89.6 cubic feet. To convert a given number of cords into solid cubic feet, multiply by 128 and then multiply the product by 0.7 or 0.6, according as the wood is split or consists of small round sticks; or multiply directly by 89.6.

To convert a given number of solid cubic feet into cords, divide by 128 and then divide the result by 0.7 or 0.6, according to the form of the wood; or divide directly by 89.6. If the stacking is very poor or if the wood is rough and crooked, the figures must be modified.

No rule can be given for converting cord measure into board measure. Lumbermen assign to a cord of wood values varying from 500 to 1,000 board feet. So much depends upon the quality of the wood, the purpose for which it is to be used, the method of piling, etc., that no constant converting factor can be given.

Bark is piled in stacks and measured in the same way as firewood.

CONVERSION OF CUBIC MEASURE INTO BOARD MEASURE.

The ratio between the number of board feet and cubic feet in logs depends on the species of tree, on the size of the logs, and on the method of scaling. The ratio for standing trees depends, further, on the minimum size of the merchantable log. For example, the ratio would be different, if 4 logs were cut from a tree, from the result if only 3 logs were taken. Satisfactory figures can, therefore, be obtained only by comparing the scales of logs and trees actually measured in the woods. Such tables are now being prepared by the Bureau of Forestry for different species in different regions.

MEASUREMENT OF SAWED LUMBER—BOARD MEASURE.

The superficial measure of inch boards is obtained by multiplying the width in inches by the length in feet and dividing by 12. Tables showing the contents of boards of different widths and lengths are published in practically every lumberman's ready reckoner, of which there are many on the market.

The contents of boards thicker than 1 inch are obtained by multiplying the width in inches by the thickness in inches and the product by the length in feet, and then dividing by 12.—*The Woodman's Handbook.*

HARDNESS OF MINERALS:

1. Talc. 2. Rock Salt.	Scratched by finger nail.
3. Calcite 4. Fluor 5. Apatite 6. Orthoclase	Scratched by a knife blade.
7. Quartz 8. Topaz 9. Corundum 10. Diamond	May be roughly distinguished by a file.

HEAT—ITS MECHANICAL EQUIVALENT.

HEAT is a peculiar motion of the particles of matter which prevents their contact. Heat and mechanical power are convertible forms of energy. The energy of the heat that raises one pound of water 1° F. will lift a weight of 778 lbs. one foot. The power of a weight of 778 lbs. descending one foot, if applied to a small paddle wheel turning in one pound of water, will, by friction, raise the temperature of the water 1° F.

A heat-unit is the amount of heat that raises a pound of water 1° F., or that lifts a weight of 778 lbs. one foot.

The mechanical equivalent of a heat-unit is the power of a weight of 778 lbs. descending one foot, or of a one-pound weight descending 778 feet. Hence,

778 foot-pounds = 1 heat-unit.
1 heat-unit = 778 foot-pounds.

A galvanic battery that produces an electrical current capable of heating one pound of water 1° F., will yield magnetic force sufficient to raise a weight of 778 lbs. one foot high.

Thus heat, electricity, magnetism, and chemical force are brought into numerical correlation with mechanical power.

The illustrious philosopher, Dr. J. P. Joule, of Manchester, England, first measured accurately the mechanical equivalent of heat, A.D. 1845.

Heat of Metals.—A metal is an element possessing a luster, and the higher oxides of which only are acid-forming compounds. Metals have the following properties: A specific gravity usually greater than one. The specific heat is less than unity, and this heat varies inversely as the atomic weight of that element. The conductivity of the metals is greater than that of either the non-metals or their compounds.

The influence of heat upon metals is very varied; some melt at a low temperature, others require a red heat, a strong red, or a white heat respectively, to melt them. The following table, by Pouillet, will explain the temperatures corresponding to different colors:

Heat Color.	Corresponds to	
Incipient red heat.	525° C.	977° F.
Dull red.	700	1,292
Incipient cherry red. . .	800	1,472
Cherry red.	900	1,652
Clear cherry red.	1,000	1,832
Deep orange.	1,100	2,012
Clear orange.	1,200	2,192
White.	1,300	2,372
Bright white.	1,400	2,552
Dazzling white.	1,500	2,732

STEAM PRESSURE AND TEMPERATURE.

Pressure in Lbs. per Sq. In.	Corresponding Temperature, Fahrenheit.	Pressure in Lbs. per Sq. In.	Corresponding Temperature, Fahrenheit.	Pressure in Lbs. per Sq. In.	Corresponding Temperature, Fahrenheit.
10	192.4	65	301.3	140	357.9
15	212.8	70	306.4	150	363.4
20	228.5	75	311.2	160	368.7
25	241.0	80	315.8	170	373.6
30	251.6	85	320.1	180	378.4
35	260.9	90	324.3	190	382.9
40	269.1	95	328.2	200	387.3
45	276.4	100	332.0	210	391.5
50	283.2	110	339.2	220	395.5
55	289.3	120	345.8	230	399.4
60	295.6	130	352.1	240	403.1

TABLE OF TEMPERATURE.

Degree of Fahr.	
2,786	Cast iron melts (Daniell).
1,996	Copper melts (Daniell).
1,947	Gold melts.
1,873	Silver melts (Daniell).
1,750	Brass (containing 25% of zinc) melts (Daniell).
1,000	Iron, bright cherry red (Poillet).
980	Red heat, visible in daylight (Daniell).
941	Zinc begins to burn (Daniell).
773	Zinc melts (Daniell).
644	Mercury boils (Daniell), 662 (Graham).
640	Sulphuric acid boils (Marignac), 620 (Graham).
630	Whale oil boils (Graham).
617	Pure lead melts (Rudberg).
600	Linseed oil boils.
518	Bismuth melts (Gmelin).
442	Tin melts (Crichton).
380	Arsenious acid volatilizes.
356	Metallic arsenic sublimes.
315	Oil of turpentine boils (Kaure).
302	Etherification ends.
257	Saturated sol. of sal ammoniac boils (Taylor).
256	Saturated sol. of acetate of soda boils.
239	Sulphur melts (Miller), 226 (Fownes).
238	Saturated sol. of nitre boils.
221	Saturated sol. of salt boils (Paris Codex).
220	Saturated sol. of alum, carb. soda, and sulph. zinc, boil.
218	Saturated sol. of chlorate and prussiate potash, boil.
216	Saturated sol. of sulph. iron, sulph. copper, nitrate of lead, boil.
214	Saturated sol. of acetate lead, sulph. and bitartrate potash, boil.
213 or (213.5)	Water begins to boil in glass.
212	Water boils in metal, barometer at 30°.
211	Alloy of 5 bismuth, 3 tin, 2 lead, melts.
201	Alloy of 8 bismuth, 5 lead, 3 tin, melts (Kane).
207	Sodium melts (Regnault).
185	Nitric acid 1.52 begins to boil.
180 (about)	Starch forms a gelatinous compound with water.
176	Rectified spirit boils, benzol distils.
173	Alcohol (sp. gr. .796 to .800) boils.
151	Beeswax melts (Kane), 142 (Lepage).
150	Pyroxylic spirit boils (Scanlan).
145	White of egg begins to coagulate.
141.8	Chloroform, and ammonia of .945, boil.
132	Acetone (pyroacetic spirit) boils (Kane).
122	Mutton suet and styracin melt.
116	Bisulphuret of carbon boils (Graham).
115	Pure tallow melts (Lepage), 92 (Thomson).
112	Spermaceti and stearin of lard melt.
111	Phosphorus melts (Miller).
98	Temperature of the blood.
95	Ether (.720) boils.
95	Carbolic acid crystals become an oily liquid.
88	Acetous fermentation ceases, water boils *in vacuo*.
77	Vinous ferm. ends, acetous ferm. begins.
64.4	Oil of anise liquefies.
59	Gay Lussac's *Alcoomètre* graduated at.
55	Sirups to be kept at.
30 (about)	Olive oil becomes partially solid.
32	Water freezes.
5	Cold produced by snow 2 parts and salt 1 part.
−37.9	Mercury freezes.

—*Cooley*.

LINEAR EXPANSION OF SOLIDS AT ORDINARY TEMPERATURES.

Substance.	For 1° Fahr.	For 1° Cent.
	Length = 1.	Length = 1.
Aluminium (cást)	.00001234	.00002221
Antimony (cryst.)	.00000627	.00001129
Brass, cast	.00000957	.00001722
" English plate	.00001052	.00001894
" sheet	.00001040	.00001872
Brick, best stock	.00000310	.00000550
Bronze (Baily's). Copper, 17. Tin, 2½. Zinc, 1.	.00000986	.00001774
"	.00000975	.00001755
Cement, Roman, dry	.00000797	.00001435
Cement, Portland (mixed), pure	.00000594	.00001070
Cement, Portland, mortar, with sand	.00000656	.00001180
Concrete: cement mortar and pebbles	.00000795	.00001430
Copper	.00000887	.00001596
Ebonite	.00004278	.00007700
Glass, English flint	.00000451	.00000812
" French flint	.00000484	.00000872
" white, free from lead	.00000492	.00000886
" blown	.00000498	.00000896
" thermometer	.00000499	.00000897
" hard	.00000397	.00000714
Granite, gray, dry	.00000438	.00000789
" red "	.00000498	.00000897
Gold, pure	.00000786	.00001415
Iridium, pure	.00000356	.00000641
Iron, wrought	.00000648	.00001166
" Swedish	.00000636	.00001145
" cast	.00000556	.00001001
" soft	.00000626	.00001126
Lead	.00001571	.00002828
Marble, moist	.00000663	.00001193
" dry	.00000363	.00000654
" white Sicilian, dry	.00000786	.00001415
Marble, black Galway	.00000308	.00000554
" Carrara	.00000471	.00000848
Masonry, of brick in cement mortar: headers	.00000494	.00000890
Masonry, of brick in cement mortar: stretchers	.00000256	.00000460
Mercury (cubic expansion)	.00009984	.00017971
Nickel	.00000695	.00001251
Osmium	.00000317	.00000570
Palladium, pure	.00000556	.00001000
Pewter	.00001129	.00002033
Plaster, white	.00000922	.00001660
Platinum	.00000479	.00000863
Platinum, 90 per cent. Iridium, 10 per cent., hammered and annealed	.00000476	.00000857
Platinum, 85 per cent. Iridium, 15 per cent.	.00000453	.00000815
Porcelain	.00000200	.00000360
Quartz, parallel to major axis, t 0° to 40° C.	.00000434	.00000781
Quartz, perpendicular to major axis, t 0° to 40° C.	.00000788	.00001419
Quartz, cubic expansion at 16° C.	.00001924	.00003463
Silver, pure	.00001079	.00001943
Slate	.C0000577	.00001038
Steel, cast	.00000636	.00001144
" tempered	.00000689	.00001240
Stone (sandstone), dry	.00000652	.00001174
Stone (sandstone), Rauville	.00000417	.00000750
Stone (sandstone), Caen	.00000494	.00000890
Tin	.00001163	.00002094
Wedgwood ware	.00000489	.00000881
Wood, pine	.00000276	.00000496
Zinc	.00001407	.00002532
Zinc, 8. Tin, 1.	.00001496	.00002692

—Clark's Mechanical Engineer's Pocket Book.

EXPANSION OF LIQUIDS.

The cubical expansion, or expansion of volume, of water, from 32° F. to 212° F. and upwards, is given in the following Table. The rate of expansion increases with the temperature. The expansion for the range of temperature from 32° to 212° is .0466, or fully 4⅔ per cent. of the volume at 32°; or an average of .000259 per degree, or $\frac{1}{3863}$ part of the volume at 32° F.

Expansion of Liquids from 32° to 212° F.

Volume at 32° = 1.

Liquid.	Volume at 212°.	Expansion.
Alcohol	1.1100	$\frac{1}{9}$
Nitric acid	1.1100	$\frac{1}{9}$
Olive oil	1.0800	$\frac{1}{12}$
Turpentine	1.0700	$\frac{1}{14}$
Sea water	1.0500	$\frac{1}{20}$
Water	1.0466	$\frac{1}{22}$
Mercury	1.018	$\frac{1}{55}$

FRICTION.—The ratio obtained by dividing the entire force of friction by the normal pressure is called the coefficient of friction. The unit or coefficient of friction is the friction due to a normal pressure of one pound:

Iron on oak	0.62
Cast iron on oak	0.49
Oak on oak, fibres parallel	0.48
Oak on oak, greased	0.10
Cast iron on cast iron	0.15
Wrought iron on wrought iron	0.14
Brass on iron	0.16
Brass on brass	0.20
Wrought iron on cast iron	0.19
Cast iron on elm	0.19
Soft limestone on the same	0.64
Hard limestone on the same	0.38
Leather belts on wooden pulleys	0.47
Leather belts on cast-iron pulleys	0.28
Cast iron on cast iron, greased	0.10

Pivots or axes of wrought or cast iron, on brass or cast-iron pillows:

First, when constantly supplied with oil	0.05
Second, when greased from time to time	0.08
Third, without any application	0.15

STRENGTH OF MATERIALS.

METALS.

Name of Metal.	Tensile Strength in Pounds per Sq. In.
Aluminum wire	30,000–40,000
Brass wire, hard drawn	50,000–150,000
Bronze, phosphor, hard drawn	110,000–140,000
" silicon " "	95,000–115,000
Copper wire, hard drawn	60,000–70,000
Gold * wire	38,000–41,000
Iron, † cast	13,000–29,000
" wire, hard drawn	80,000–120,000
" " annealed	50,000–60,000
Lead, cast or drawn	2,600–3,300
Palladium *	39,000
Platinum * wire	50,000
Silver * wire	42,000
Steel, mild, hard drawn	100,000–200,000
" hard " "	150,000–330,000
Tin, cast or drawn	4,000–5,000
Zinc, cast	7,000–13,000
" drawn	22,000–30,000

STONES AND BRICKS.

Name of Substance.	Resistance to Crushing in Pounds per Sq. In.
Basalt	18,000–27,000
Brick, soft	300–1,500
" hard	1,500–5,000
" vitrified	9,000–26,000
Granite	17,000–26,000
Limestone	4,000–9,000
Marble	9,000–22,000
Sandstone	4,500–8,000
Slate	11,000–30,000

TIMBER.

Name of Wood	Tensile Strength in Pounds per Sq. In.	Resistance to Crushing in Pounds per Sq. In.
Ash	11,000–21,000	6,000–9,000
Beech	11,000–18,000	9,000–10,000
Birch	12,000–18,000	5,000–7,000
Chestnut	10,000–13,000	4,000–6,000
Elm	12,000–18,000	6,000–10,000
Hackberry	10,000–16,000	....
Hickory	15,000–25,000	7,000–12,000
Maple	8,000–12,000	6,000–8,000
Mulberry	8,000–14,000	....
Oak, burr	15,000–20,000	7,000–10,000
" red	13,000–18,000	5,000–7,000
" water	12,000–16,000	4,000–6,000
" white	20,000–25,000	6,000–9,000
Poplar	10,000–15,000	5,000–8,000
Walnut	8,000–14,000	4,000–8,000

* On the authority of Wertheim.

† The crushing strength of cast iron is from 5.5 to 6.5 times the tensile strength.

NOTES.—According to Boys, quartz fibers have a tensile strength of between 116,000 and 167,000 pounds per square inch.

Leather belting of single thickness bears from 400 to 1,600 pounds per inch of its breadth. —*Smithsonian Tables.*

WATER.

1 U. S. gallon equals 231 cubic inches; .1337 cubic foot; 8.333 pounds of water at 62° F.; 3.786 liters.

1 cubic inch of water at 62° F. equals .03608 pound; .5773 ounce; 252.6 grains; .004326 U. S. gallon; .01638 liter.

1 cubic foot of water at 62° F. equals 62.355 pounds; 997.68 ounces (about 1000); .557 cwt. (of 112 pounds); .0278 long ton; 7.4805 U. S. gallons; 28.315 liters; .02832 cubic meter.

1 cylindrical inch of water at 62° F. equals .02833 pound; .4533 ounce; .7854 cubic inch.

1 cylindrical foot of water at 62° F. equals 48.973 pounds (about 50); 783.57 ounces; .437 cwt. (of 112 pounds); .0219 long ton; 5.8758 U. S. gallons; 22.2380 liters; .02224 cubic meter.

1 cubic yard of water equals 1,684.8 pounds; 15.043 cwt. (of 112 pounds), or 15 cwt. 4.8 pounds; .7645 cubic meter.

1 liter of water equals 2.2046 pounds at 62° F.; .2641 U. S. gallon; 61.025 cubic inches; .0353 cubic foot.

1 cubic meter of water equals 1 metric ton, or 1,000 kilograms at 39.1° F. or 4° C.; 2,204.62 pounds at 39.1° F. or 4° C.; 2,203.7 pounds at 62.4 pounds per cubic foot; 1 ton of 2,240 pounds, nearly; 1 tun of 4 hogsheads, or 2,100 pounds, nearly; 264.2 U. S. gallons; 1.308 cubic yards; 35.3156 cubic feet; 1,000 liters.

The weight of fresh water is commonly assumed, in ordinary calculations, to be 62.4 pounds per cubic foot, which is the weight at 52.3° F. It is frequently taken as 62½ pounds or 1,000 ounces per cubic foot.

The volumes of given weights of water, at the rate of 62.4 pounds per cubic foot, are as follows:

1 ton (long), 35.90 cubic feet (about 36); 1 cwt. (of 112 pounds), 1.795 cubic feet; 1 pound, .016 cubic feet or 27.692 cubic inches; 1 ounce, 1.731 cubic inches; 1 metric ton, at 39.1° F. or 4° C., 35.3156 cubic feet; 1 kilogram, at 39.1° F. or 4° C., .0353 cubic feet or 61.025 cubic inches; 1 metric ton, at 52.3° F. (62.4 pounds per cubic foot), 35.330 cubic feet.

A pipe 1 yard in length holds about as many pounds of water at ordinary temperatures as the square of its diameter in inches (about two per cent. more).

A column of water at 62° F., 1 foot high, is equivalent to a pressure of .433 pound or 6.928 ounces per square inch of base; or to 62.355 pounds per square foot.

A column of water 1 inch high is equivalent to a pressure of .5773 ounce or .03608 pound per square inch; or to 5.196 pounds per square foot.

A column of water 100 feet high is equivalent to 43¼ pounds per square inch; or 2.786 tons per square foot.

A column of water 1 mile deep, weighing 62.4 pounds per cubic foot, is equivalent to a pressure of about 1 ton per square inch.

1 pound per square inch is equivalent to a column of water at 62° F. 2.31 feet or 27.72 inches high.

SEA WATER.

1 cubic foot at 62° F., 64 pounds; 1 cubic yard, 15½ cwt., nearly (8 pounds less); 1 cubic meter, 1 long ton, fully (20 pounds more); 1 ton, 35 cubic feet.

Ratio of weight of fresh water to that of sea water, 39 to 40, or 1 to 1.028.

ICE AND SNOW.

1 cubic foot of ice at 32° F., 57.50 pounds; 1 pound of ice at 32° F., .0174 cubic foot, or 30.067 cubic inches; specific density of ice, .922; that of water at 62° F. being 1.

AIR.

1 cubic foot, at 14.7 lbs. per square inch, or 1 atmosphere, equals .080728 lb. at 32° F.; 1.29 ounce at 32° F.; 565.1 grains at 32° F.; .076097 lb. at 62° F.; 1.217 ounce at 62° F.; 532.7 grains at 62° F.

1 liter, under 1 atmosphere, equals 1.293 grams at 32° F.; 19.955 grains at 32° F.

1 lb. of air at 62° F. equals 13.141 cubic feet.

The weights of equal volumes of mercury, water, and air, at 62° F. under 1 atmosphere, are as 11,140.56, 819.4, and 1.

1 atmosphere of pressure equals 14.7 lbs. per square inch; 2,116.4 lbs. per square foot; 1.0335 kilograms per square centimeter; 29.922 inches of mercury at 32° F.; 76 centimeters of mercury at 32° F.; 30 inches of mercury at 62° F.; 33.947 feet of water at 62° F.; 10.347 meters of water at 62° F.

1 lb. per square inch equals 2.035 inches of mercury at 32° F.; 51.7 millimeters of mercury at 32° F.; 2.04 inches of mercury at 62° F.; 2.31 feet of water at 62° F.; 27.72 inches of water at 62° F.

1 ounce per square inch equals 1.732 inches of water at 62° F.

1 lb. per square foot equals .1925 inch of water at 62° F.; .01417 inch of mercury at 62° F.

STRENGTH OF ICE.

Ice 2 in. thick will bear infantry.

Ice 4 in. thick will bear cavalry or light guns.

Ice 6 in. thick will bear heavy field guns.

Ice 8 in. thick will bear 24-pounder guns on sledges; weight not over 1,000 lbs. to a square foot.

WEIGHT OF BALLS.

$$W = \frac{D^3 + 00}{C};$$

$$D = \sqrt[3]{W \times C - 00.}$$

When D = diameter of ball in inches;
W = weight of ball in lbs.;
C = aconstant = 733 for cast iron;
= 464 for lead;
= 595 for copper;
= 635 for brass.

or,

$$W = D^3 \times C;$$

$$D = \sqrt[3]{W \times C.}$$

When C = a constant = 0.1364 for cast iron;
= 0.2155 for lead;
= 0.168 for copper;
= 0.1574 for brass.

Weight of cast-iron balls.

$$W = \left(\frac{D}{2}\right)^3 \times 0.1.$$

To find nominal horse-power of boiler required for direct-acting steam-pumps.

$$NHP = \frac{D^2 - \text{the last figure}}{2}.$$

When NHP = nominal horse-power;
D = diameter of steam cylinder in inches.

PIPES.

Usual inclination of pipes.

1 in. in	12 ft.	= minimum fall for house drains;
1 " "	16 "	= minimum fall for land drains;
1 " "	40 "	= minimum fall for sub-drains for houses;
1 " "	100 "	= minimum fall for main drains for houses;
1 " "	150 "	= fall of mountain torrents;
1 " "	230 "	= " " rivers and rapid currents;
1 " "	280 "	= fall of strong currents;
1 " "	340 "	= " " ordinary rivers with good current;
1 " "	440 "	= fall of winding rivers subject to inundations with slow current;
1 " "	480 "	= fall of water channels, supply pipes to reservoirs and small canals;
1 " "	570 "	= fall of large canals;
1 " "	1,000 "	= very slow current, approaching to stagnant water.

Discharge through pipes.

Discharge in 24 hours divided by 1,440 = discharge per min.; discharge in cubic feet per minute × 9,000 = imperial gallons per day of 24 hours; discharge in cubic feet per minute × 11,000 = U. S. gallons per day of 24 hours; discharge in cubic feet per second × 2.2 = cubic yards per minute; discharge in cubic feet per second × 6.24 = imperial gallons per second; discharge in cubic feet per second × 7.48 = U. S. gallons per second; discharge in cubic feet per second × 133 = cubic yards per hour; discharge in cubic feet per second × 375 = imperial gallons per minute; discharge in cubic feet per second × 450 = U. S. gallons per minute; discharge in cubic feet per second × 2,400 = long tons per day of 24 hours; discharge in cubic feet per second × 2,700 = short tons per day of 24 hours; velocity in feet per second × 0.68 = mile per hour; velocity in feet per second × 60 = feet per minute; velocity in feet per second × 20 = yards per minute; pressure head of water in feet = pressure of water in lbs. per square foot × 0.016; pressure of water in lbs. per square foot = head in feet × 62.32.

ANIMAL POWER—HORSE.

A horse walking in a circle at a speed of 176 feet per minute will raise with a common deep-well pump—

4 h. per day	1,653 gals. per min.;	1 ft. high.
5 " " "	1,480 " " "	" " "
6 " " "	1,350 " " "	" " "
8 " " "	1,160 " " "	" " "
10 " " "	1,040 " " "	" " "

Tractive force of a horse when working 8 hours a day on a well-made road and walking at a rate of 2½ miles per hour, 150 lbs.

Tractive force of a horse when working a lift or horse-run with intervals of rest between each movement, the day's work not to exceed 6 hours, 300 lbs.

Tractive force of a horse when working in a circle of 30 feet diameter in working a mill for 8 hours per day at a pace of 2 miles per hour, 100 lbs.

A horse can exert a force horizontally at a dead pull, 400 lbs.

A horse can carry on his back a distance of 20 miles per day on a well-made road, without overexertion, from 250 to 300 lbs.

The horse-power adopted as a unit in estimating the force of a steam-engine = 33,000 lbs. raised 1 foot high in 1 minute, an amount of force which few horses could perform for any length of time.

MANUAL POWER.

Duration of work = 1 day of 8 to 10 hours.

Description of Work	Mean Effect in Lbs.	Velocity in Feet per Minute.	Lbs. Raised 1 Foot High per Minute.
Lifting weights by hand breast high	40	25	1,000
Raising water from a well by a bucket and rope	30	35	1,050
Lifting a weight by a rope and overhead tackle	40	30	1,200
Working a hand pump	30	60	1,800
Drawing a canal boat	12	160	1,920
Working a ship's capstan	25	100	2,500
Turning the crank of a winch	15	200	3,000
Rowing a boat	40	80	3,200

The efforts in the above table, although extending over 8 or 10 hours, exclusive of meal-times, per day, are not altogether continuous, but include the usual intervals of rest or diminished exertion peculiar to each class of work.

WINDMILLS.

To find the horse-power of a wind-engine.

$$HP = \frac{A \times V^2}{1,100,000}.$$

When HP = effective horse-power;
A = area of sails in square feet;
V = velocity of the wind in feet per second.

To find the area of sails required for a given horse-power.

$$A = \frac{HP \times 1,100,000}{V^2}.$$

The best effect is obtained when the total surface of the sails presented to the wind does not cover more than a quarter of the surface of the whole disk described by the radial arms or whips.

To find the force of wind.

$$P = 0.002288\ V^2;$$
$$P = 0.00422\ V_1^2;$$
$$P = 0.0023\ V^2 \times \sin X.$$

When P = pressure in lbs. per square foot;
V = velocity in feet per second;
V_1 = velocity in miles per hour;
X = angle of incidence of direction of the wind with the plane of the surface when it is oblique.

To find the angle of the sails.

$$a = 23° - \frac{18D^2}{R^2}.$$

When a = angle of the sail with the plane of motion at any part of the sail;
D = distance of any part of the sail from the axis in feet;
R = total radius of sail in feet.

To find angle of shaft with horizon.

a = 8 degrees on level ground;
= 15 degrees on high ground.

To find breadth of whip.

$$B = \tfrac{1}{30}W;$$
$$D = \tfrac{1}{40}W;$$
$$B_1 = \tfrac{1}{60}W;$$
$$D_1 = \tfrac{1}{80}W;$$
$$W_1 = \tfrac{1}{3}W.$$

When W = length of whip in feet;
W_1 = width of sail in feet;
B = breadth of whip at axis in feet;
D = depth of whip at axis in feet;
B_1 = breadth of whip at tip in feet;
D_1 = depth of whip at tip in feet;

Divided by the whip in the proportion of 5 to 3, the narrow portion being nearest to the wind.

$$W_{11} = \tfrac{1}{8}W;$$
$$D_{11} = \tfrac{1}{7}W.$$

When W_{11} = width of sail at axis;
D_{11} = distance of sail from axis.

Cross-bars from 16 to 18 inches apart.

Velocity of tip of sails = 2.6 V, nearly.

In examining the ratio between the velocity of *the wind and the number of revolutions* of the wheel-shaft Mr. Smeaton obtained the result in table below, for Dutch sails, in their common position, when the radius of the wheel was 30 feet:

Number of Revolutions of Wheel-shaft per Minute.	Velocity of Wind in an Hour.	Ratio between Velocity of the Wind and Revolutions of Wheel-shaft.
3	2 miles	0.666
5	4 "	0.800
6	5 "	0.833

The most efficient angles.

Part of Radius which is Divided in Six Parts.	Angle with the Axis.	Angle of Weather.
1	72°	18°
2	71°	19°
3	72°	18° middle
4	74°	16°
5	77½°	12½°
6	83°	7°

Supposing the radius of the sail to be 30 feet, then the sail will commence at ⅙th, or 5 feet from the axis, where the angle of inclination will be 72°, at ⅖ths or 10 feet from the axis will be 71°, and so on.

In order to utilize the maximum effect of wind, therefore, it is necessary to load the wind-engine so that the number of revolutions of the wheel is proportional to the velocity of the wind.

To find proper number of revolutions of a wind-mill.

$$N = \frac{3.16 \times V}{L \times \sin U};$$

if $U = 16°$,

$$N = \frac{11.5\ V}{L};$$

When N = number of revolutions of wheel per minute;
V = velocity of the wind in feet per second;
$L = \sqrt{\dfrac{R^2 + R_1^2}{2}}$ = radius of center of percussion in feet;
R = extreme radius of wheel in feet;
R_1 = inner radius of wheel in feet;
U = mean angle of sails to the plane of motion.

FORCE OF WIND WHEN BLOWING PERPENDICULARLY UPON A SURFACE OF ONE SQUARE FOOT.

Velocity of Wind.			Perpendicular Force on One Square Foot in Lbs.	Description.
Miles per Hour.	Feet per Minute.	Feet per Second.		
1	88	1.47	.005	Hardly perceptible
2	176	2.93	.020	Just perceptible
3	264	4.40	.044	" "
4	352	5.87	.079	Gentle breeze
5	440	7.33	.123	" "
10	880	14.67	.492	Pleasant
15	1,320	22.00	1.107	"
20	1,760	29.30	1.968	Brisk gale
25	2,200	36.60	3.075	" "
30	2,640	44.00	4.428	High wind
35	3,080	51.30	6.027	" "
40	3,520	58.60	7.872	Very high wind
45	3,960	66.00	9.963	" " "
50	4,400	73.30	12.300	Storm
60	5,280	88.00	17.712	Great storm
70	6,160	102.7	24.108	" "
80	7,040	117.3	31.488	Hurricane
100	8,800	146.6	49.200	"

—Whittaker's Mechanical Engineer's Pocket Book.

METALS: WEIGHTS FOR VARIOUS DIMENSIONS.

Metal.	Specific Weight.	Weight of One Cubic Foot.	Weight of One Square Foot.			Weight of One Linear Foot 1 In. Sq.	Weight of One Cubic Inch.
			1 Inch Thick.	$\frac{1}{8}$ Inch Thick.	$\frac{1}{10}$ Inch Thick.		
	Wrought Iron = 1.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Aluminum, wrought	.348	167	13.92	1.74	1.39	1.160	.097
" cast	.333	160	13.33	1.67	1.33	1.111	.092
Antimony	.879	418	34.83	4.35	3.48	2.902	.242
Bismuth	1.285	617	51.42	6.42	5.14	4.283	.357
Brass, cast	1.052	505	42.08	5.26	4.21	3.507	.292
" sheet	1.098	527	43.92	5.49	4.39	3.652	.304
" yellow	1.079	518	43.17	5.40	4.32	3.597	.298
" Muntz metal	1.062	511	42.58	5.32	4.26	3.549	.296
" wire	1.110	533	44.42	5.55	4.44	3.701	.308
Bronze, gun-metal	1.106	531	44.25	5.54	4.43	3.688	.307
" mill bearings	1.133	544	45.33	5.66	4.53	3.780	.315
" small bells	1.004	482	40.17	5.04	4.02	3.347	.279
" speculum metal	.969	465	38.75	4.84	3.88	3.299	.269
Copper, sheet	1.114	549	45.75	5.72	4.58	3.813	.318
" hammered	1.158	556	46.33	5.79	4.63	3.861	.322
" wire	1.154	554	46.17	5.77	4.62	3.778	.315
Gold	2.500	1200	100.00	12.50	10.00	8.333	.694
Iron, cast	.937	450	37.50	4.69	3.75	3.125	.260
" wrought	1.000	480	40.00	5.00	4.00	3.333	.278
Lead, sheet	1.483	712	59.33	7.41	5.93	4.944	.412
Manganese	1.040	499	41.58	5.20	4.16	3.465	.289
Mercury	1.769	849	70.75	8.84	7.07	5.896	.491
Nickel, hammered	1.127	541	45.08	5.64	4.51	3.757	.313
" cast	1.075	516	43.00	5.37	4.30	3.583	.299
Platinum	2.796	1342	111.83	13.97	11.18	9.320	.777
Silver	1.365	655	54.58	6.82	5.46	4.549	.379
Steel	1.020	490	40.83	5.12	4.10	3.403	.284
Tin	.962	462	38.50	4.81	3.85	3.208	.268
Zinc, sheet	.935	449	37.42	4.67	3.74	3.118	.260
" cast	.892	428	35.67	4.46	3.57	2.972	.248

—Clark's Mechanical Engineer's Pocket Book.

PROPORTIONATE WEIGHT OF CASTING TO WEIGHT OF WOOD PATTERN.

A Pattern Weighing One Pound, Made of (less weight of core prints)	Cast Iron.	Brass.	Copper.	Bronze.	Bell Metal.	Zinc.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Pine or fir will weigh in..........	14	15.8	16.7	16.3	17.1	13.5
Oak " " "	9	10.1	10.4	10.3	10.9	8.6
Beech " " "	9.7	10.9	11.4	11.3	11.9	9.1
Linden " " "	13.4	15.1	16.7	15.5	16.3	12.9
Pear " " "	10.2	11.5	11.9	11.8	12.4	9.8
Birch " " "	10 6	11.9	12.3	12.2	12.9	10.2
Alder " " "	12.8	14.3	14.9	14.7	15.5	12.2
Mahogany " " "	11.7	13.2	13.7	13.5	14.2	11.2
Brass " " "	0.84	0.95	0.99	0.98	1.0	0.81

PULLING STRENGTH OF MEN AND ANIMALS.

Compiled from a test made by Barnum & Bailey's Circus.

Number.	Description.	Weight of Each in Lbs.	Total Pull in Lbs.	Pull per Unit.	Pull per Pound of Weight.
2	Horses.............	1,600	3,750	1,875	1.172 lbs.
50	Men...............	150	8,750	175	1.166 "
100	Men...............	150	12,000	120	0.8 "
6	Horses.............	1,800	8,875	1,479	0.822 "
2	Camels.............	1,800	2,750	1,375	0.764 "
1	Elephant...........	12,000	8,750	8,750	0.729 "

ELEPHANT, WEIGHING 12,000 POUNDS, ABOUT TO MAKE A PULL OF 8,750 POUNDS.

BOILER TUBES.

The following table gives the draught area and heating surface of the various-sized boiler tubes and flues:

External Diameter.	Draught Area in Square Inches.	Draught Area in Square Feet.	Outside Heating Surface in Feet per Foot of Tube in Length.	Number of Tubes in One Square Foot of Draught Area.
⅝	......	......	.1636	......
¾	......	......	.1963	......
1	.575	.0040	.2618	250.0
1¼	.968	.0067	.3272	149.3
1½	1.389	.00964	.3927	103.7
1¾	1.911	.0133	.4581	75.2
2	2.573	.0179	.5236	55.9
2¼	3.333	.0231	.5891	43.3
2½	4.083	.0284	.6545	35.2
2¾	5.027	.0349	.7200	28.7
3	6.070	.0422	.7854	23.7
3¼	7.116	.0494	.8508	20.2
3½	8.347	.0580	.9163	17.2
3¾	9.676	.0672	.9818	14.9
4	10.93	.0759	1.0472	13.2
4½	14.05	.0996	1.1781	10.2
5	17.35	.1205	1.3090	8.3
6	25.25	.1753	1.5708	5.7
7	34.94	.2426	1.8326	4.1
8	46.20	.3208	2.0944	3.1
9	58.63	.4072	2.3562	2.5
10	72.23	.5016	2.6180	2.0

TO OBTAIN INDEX OF A LATHE.

How to Obtain the Index of an Engine Lathe.—If you will note what thread the lathe will cut when two given gears are in place, you can easily construct a table that will show you just what thread any two gears will cause the lathe to cut. Suppose that two sixty-threes cause 12 threads to the inch. Then place 12 in the space A in the diagram below.

Stud.

SCREW	28	33	35	42	49	56	63	70	77	84	91	98	105	112
28														
33														
35														
42														
49					b									
56						a	C							
63						B	A	D						
70							E	c						
77									d					
84														
91														
98														
105														
112														

Now, 63 : 56 :: A : C } Direct proportion.
63 : 70 :: A : E }
Also, 56 : 63 :: A : B } Inverse proportion.
70 : 63 :: A : D }

The spaces may all be filled except a, b, c, d, etc., which it is useless to fill, as only your 63 gear is duplicated. A half-day's time will be sufficient for a good mathematician to fill out the table.

Nails, Memoranda Concerning.—This table will show at a glance the length of the various sizes, and the number of nails in a pound. They are rated from "3-penny" up to "20-penny." The first column gives the name, the second the length in inches, and the third the number per pound:

3-penny,	1 in. long,	557 per lb.
4-penny,	1¼ in. long,	353 per lb.
5-penny,	1¾ in. long,	232 per lb.
6-penny,	2 in. long,	167 per lb.
7-penny,	2¼ in. long,	141 per lb.
8-penny,	2½ in. long,	101 per lb.
10-penny,	2¾ in. long,	98 per lb.
12-penny,	3 in. long,	54 per lb.
20-penny,	3½ in. long,	34 per lb.
Spikes,	4 in. long,	16 per lb.
Spikes,	4½ in. long,	12 per lb.
Spikes,	5 in. long,	10 per lb.
Spikes,	6 in. long,	7 per lb.
Spikes,	7 in. long,	5 per lb.

From this table an estimate of quantity and suitable sizes for any job can be easily made.

The relative adhesion of nails in the same wood, driven transversely and longitudinally, is as 100 to 78, or about 4 to 3 in dry elm, and 2 to 3 in deal.

Horse-power, very Rough Way of Estimating.—The power of a steam engine is calculated by multiplying together the area of the piston in inches, the mean steam pressure in pounds per square inch, the length of stroke in feet, and the number of strokes per minute, and dividing the product by 33,000. Or, multiply the square of the diameter of the cylinder in inches by 0.7854, and this product by the mean engine pressure, and the last product by the piston travel in feet per minute. Divide the last product by 33,000 for the indicated horse-power. In

the absence of logarithmic formulæ or expansion table, multiply the boiler pressure for ⅝ cut-off by 0.91; for ½ cut-off by 0.85, ⅜ cut-off by 0.75, $\frac{3}{10}$ cut-off by 0.68. This will give the mean engine pressure per square inch near enough for ordinary practice, for steam pressures between 60 and 100 lbs., always remembering that the piston travel is twice the stroke multiplied by the number of revolutions per minute.

Castings, Contraction of.—By Messrs. Bowen & Co., brass founders, London.

	Inch.	Ins. of length.
In thin brass castings......	⅛	in 9
In thick " "	⅛	in 10
In zinc castings............	$\frac{5}{16}$	in 12
In lead, according to purity.	$\frac{3}{16}$ to $\frac{5}{16}$	in 12
In copper " " " .	$\frac{3}{16}$ to $\frac{7}{32}$	in 12
In tin, " " " .	$\frac{1}{32}$ to $\frac{1}{16}$	in 12
In silver, " " " .	⅛	in 12
In cast iron, according to purity, small castings....	$\frac{1}{10}$	in 12
In cast steel, according to purity, pipes............	¼	in 12

The above values fluctuate with the form of pattern, amount of ramming, and temperature of metal when poured. Green sand castings contract less than loam or dry sand castings.

Gearing, Simple Rules on.—The following rules will apply to both bevel and spur gears. When the term pitch is used, it always signifies diametrical, not circular pitch. For illustrations we will use gears having 64 teeth and 8 pitch.

To Find Pitch Diameter.—Divide the number of teeth by the pitch: 64÷8=8 in. pitch diameter.

To Find Number of Teeth.—Multiply the pitch diameter by the pitch: 8 in.×8=64, number of teeth.

To Find the Pitch.—Divide the number of teeth by the pitch diameter: 64÷8 in.=8, pitch.

To Find Outside Diameter of Spur Wheels.—Add 2 to the number of teeth and divide by the pitch: 64+2=66÷8=8¼ in. O. D.

To Find Circular Pitch.—Divide the decimal 3.1416 by the diametrical pitch: 3.1416 ÷8=0.3927 in.

To Find the Distance between the Centers of Two Spur Gears.—Divide half the sum of the teeth of both gears by the pitch: 64+64=128 ÷2=64÷8=8 in. centers.

Pulleys, Rules for Calculating the Speed of.—The diameter of the driven being given, to find its number of revolutions —

Rule.—Multiply the diameter of the driver by its number of revolutions, and divide the product by the diameter of the driven; the quotient will be the number of revolutions of the driven.

Ex.—Twenty-four in. diameter of driver ×150, number of revolutions, =3,600÷12 in. diameter of driven=300.

The diameter and revolutions of the driver being given, to find the diameter of the driven, that shall make any given number of revolutions in the same time.

Rule.—Multiply the diameter of the driver by its number of revolutions, and divide the product by the number of required revolutions of the driven; the quotient will be its diameter.

Ex.—Diameter of driver (as before) 24 in. ×revolutions 150=3,600. Number of revolutions of driven required=300. Then 3,600 ÷300=12 in.

The rules following are but changes of the same, and will be readily understood from the foregoing examples.

To ascertain the size of the driver:

Rule.—Multiply the diameter of the driven by the number of revolutions you wish to make, and divide the product by the required revolutions of the driver; the quotient will be the size of the driver.

To ascertain the size of pulleys for given speed:

Rule.—Multiply all the diameters of the drivers together and all the diameters of the driven together; divide the drivers by the driven; the answer multiply by the known revolutions of main shaft.

Paper, Wall.—The following table from the *New York Newsdealer* shows how many rolls of wall-paper are required to cover a room of the dimensions indicated by the figures in the left-hand column, also the number of yards of border necessary·

Size of Room.	Height of Ceiling.	Number of Doors.	Number of Windows.	Rolls of Paper.	Yards of Border.
7×9	8	1	1	6	11
7×9	9	1	1	7	11
7×9	10	1	1	8	11
7×9	12	1	1	10	11
8×10..........	8	1	1	7	12
8×10..........	9	1	1	8	12
8×10..........	10	1	1	9	12
8×10..........	12	1	1	11	12
9×11..........	8	1	1	8	14
9×11..........	9	1	1	10	14
9×11..........	10	1	1	11	14
9×11..........	12	1	1	13	14
10×12..........	8	1	1	9	15
10×12..........	9	1	1	10	15
10×12..........	10	1	1	11	15
10×12..........	12	1	1	13	15
11×12..........	8	2	2	8	16
11×12..........	9	2	2	9	16
11×12..........	10	2	2	10	16
11×12..........	12	2	2	13	16
12×13..........	8	2	2	8	17
12×13..........	9	2	2	10	17
12×13..........	10	2	2	11	17
12×13..........	12	2	2	14	17
12×15 or 13×14...	8	2	2	10	18
12×15 or 13×14...	9	2	2	11	18
12×15 or 13×14...	10	2	2	12	18
12×15 or 13×14...	12	2	2	15	18
13×15..........	8	2	2	10	19
13×15..........	9	2	2	11	19
13×15..........	10	2	2	13	19
13×15..........	12	2	2	16	19
14×16..........	9	2	2	12	20
14×16..........	10	2	2	14	20
14×16..........	12	2	2	17	20
14×18..........	9	2	2	13	22
14×18..........	10	2	2	15	22
14×18..........	12	2	2	19	22
15×16..........	10	2	2	15	21
15×17..........	12	2	2	19	22

Deduct one-half roll of paper for each ordinary door or window extra—size 4×7 feet.

UNITED STATES STANDARD GAUGE.
For Sheet and Plate Iron and Steel.

Number of Gauge.	Thickness.		Weight.		Number of Gauge.
	Approximate Thickness in Fractions of an Inch.	Approximate Thickness in Decimal Parts of an Inch.	Weight per Square Foot in Ounces Avoirdupois.	Weight per Square Foot in Pounds Avoirdupois.	
0000000	1-2	.5	320	20.	0000000
000000	15-32	.46875	300	18.75	000000
00000	7-16	.4375	280	17.5	00000
0000	13-32	.40625	260	16.25	0000
000	3-8	.375	240	15.	000
00	11-32	.34375	220	13.75	00
0	5-16	.3125	200	12.5	0
1	9-32	.28125	180	11.25	1
2	17-64	.265625	170	10.625	2
3	1-4	.25	160	10.	3
4	15-64	.234375	150	9.375	4
5	7-32	.21875	140	8.75	5
6	13-64	.203125	130	8.125	6
7	3-16	.1875	120	7.5	7
8	11-64	.171875	110	6.875	8
9	5-32	.15625	100	6.25	9
10	9-64	.140625	90	5.625	10
11	1-8	.125	80	5.	11
12	7-64	.109375	70	4.375	12
13	3-32	.09375	60	3.75	13
14	5-64	.078125	50	3.125	14
15	9-128	.0703125	45	2.8125	15
16	1-16	.0625	40	2.5	16
17	9-160	.05625	36	2.25	17
18	1-20	.05	32	2.00	18
19	7-160	.04375	28	1.75	19
20	3-80	.0375	24	1.5	20
21	11-320	.034375	22	1.375	21
22	1-32	.03125	20	1.25	22
23	9-320	.028125	18	1.125	23
24	1-40	.025	16	1.	24
25	7-320	.021875	14	.875	25
26	3-160	.01875	12	.75	26
27	11-640	.0171875	11	.6875	27
28	1-64	.015625	10	.625	28
29	9-640	.0140625	9	.5625	29
30	1-80	.0125	8	.5	30
31	7-640	.0109375	7	.4375	31
32	13-1280	.01015625	6½	.40625	32
33	3-320	.009375	6	.375	33
34	11-1280	.00859375	5½	.34375	34
35	5-640	.0078125	5	.3125	35
36	9-1280	.00703125	4½	.28125	36
37	17-2560	.006640625	4¼	.265625	37
38	1-160	.00625	4	.25	38

ELECTRICAL ENGINEERING.

Units of Measurement.—The three most commonly used units are:

I. The unit of current, called the Ampere;
II. The unit of potential, called the Volt;
III. The unit of resistance, called the Ohm.

For some purposes these quantities are subdivided, thus in telegraphy the practical unit of current is the milli-ampere, *i.e.*, one-thousandth of an ampere. In some cases it is convenient to use multiples; insulation resistances are often expressed in terms of megohms, *i.e.*, a million ohms. The most commonly used multiples are the following:

1 Megohm $= 10^6$ ohms = 1 million ohms,
1 Microhm $= 10^{-6}$ ohm = 1 millionth of an ohm,
1 Kilowatt $= 10^3$ watts = 1,000 watts,
1 Micro-ampere $= 10^{-6}$ ampere = 1 millionth of an ampere.

Ohm's Law.—For steady currents the three quantities—current, potential, and resistance—are connected together by the relation discovered by Dr. Ohm, and called Ohm's Law. This law is stated thus

$$C = \frac{E}{R};$$

where C = current (amperes);
E = difference of potential (volts);
R = resistance opposing the current (ohms).

All the units in scientific work are defined in terms of the fundamental units, which are

Unit of length = 1 centimeter.
" " mass = 1 gram.
" " time = 1 second.

These are spoken of as the C.G.S. units, and in the actual determination of a standard

ohm attempts have been made to obtain the scientific value as closely as possible. The first unit used as a standard was the British Association or B.A. unit coil. Messrs. Siemens also introduced a standard ohm, but both of these units differed from the true ohm as well as from each other. In order to avoid the consequent confusion, an international congress was held at Paris in 1893 to decide upon the standard values to be adopted.

C. G. S. ELECTRICAL STANDARDS.

THE OHM is represented by the resistance offered by a column of mercury—at the temperature of melting ice—14.4521 grams in mass, of a constant cross-sectional area, and of a length of 106.3 centimeters.

THE AMPERE is represented by the unvarying electric current which, when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0.001118 of a gram per second.

THE VOLT is the electrical pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampere, and which is represented by 0.6974, or $\frac{1000}{1434}$ of the electrical pressure between the poles of the voltaic cell, known as Clark's cell, at a temperature of 15° C. (59° F.).

As in many of the older books and early papers dealing with electrical matters the older system of units is used, the following table will be useful for ascertaining the relative values of the quantities expressed:

System.	True Ohm.	Legal Ohm.	B.A. Ohm.	Siemens Ohm.
True Ohm.	1.0000	1.0025	1.0138	1.0630
Legal Ohm.	0.9975	1.0000	1.0113	1.0600
B.A. Ohm.	0.9863	0.9889	1.0000	1.0482
Siemens Ohm.	0.9408	0.9434	0.9540	1.0000

UNIT OF QUANTITY.—The quantity of electricity that flows per second past a cross-section of a conductor carrying a current of one ampere is a Coulomb.

The practical unit is the quantity that flows per hour, and is measured in ampere-hours.

UNIT OF CAPACITY: THE FARAD.—The capacity of two conductors insulated from each other is the number of coulombs of electricity required to be given to one conductor, the other being supposed at zero potential, to produce a difference of pressure of 1 volt between the two. The unit of capacity is called a "farad," and two conductors arranged in a form known as a condenser of 1 farad capacity would be raised to a difference of pressure of 1 volt by a charge of 1 coulomb of electricity. The practical unit used, however, has a capacity one-millionth of a farad—*i.e.*, a microfarad.

JOULE.—When a power of one *watt* is being developed, the work done per second is sometimes called a "Joule." Hence, *one joule* equals 0.7375 foot-lb., and

1 watt-second = 1 joule.
1 watt-minute = 60 joules.
1 horse-power hour = 1,980,000 foot-lbs.
1 horse-power hour = 2,685,600 joules.
(*W. E. Ayrton.*)

WATT.—A "watt" is the power developed in a circuit when one ampere flows through it, and when the potential difference at its terminals is one volt; hence the number of watts developed in any circuit equals the product of the current in amperes flowing through it into the potential difference at its terminals in volts. Therefore

1 watt is the power developed when 44.25 foot-lbs. of work are done per minute.

1 watt is the power developed when 0.7375 foot-lb. of work is done per second.

1 watt equals $\frac{1}{746}$th of a horse-power.
(*W. E. Ayrton.*)

CALORIE.—The amount of heat required to raise 1 kilogram of water 1° C. is the unit of heat employed on the Continent.

1 calorie = 4,200 joules = 42×10^9 ergs.
1 joule = 0.000238 calories.

INDUCTION: THE HENRY.—The induction in a circuit when the difference of electrical pressure induced in the circuit is 1 volt, while the inducing current varies at the rate of 1 ampere per second, is called a "Henry."

THE ELECTRO-MAGNETIC SYSTEM OF ELECTRIC UNITS.

UNIT OF CURRENT.—That current which, flowing in a conductor 1 centimeter long, and of 1 centimeter radius, produces at the center of the arc a magnetic field of unit strength.

This unit is ten times the ampere.

UNIT OF POTENTIAL.—Unit difference of potential exists between the ends of a conductor, when the expenditure of 1 erg per second will cause unit current to flow.

This E.M.F. is equal to one hundred-millionth of a volt.

Note.—The erg = work done by a force of 1 dyne through a distance of one centimeter = 0.001019 gramme—cent = 0.00000007386 foot-lb. (London).

UNIT OF RESISTANCE is that resistance which requires unit difference of potential to cause unit current to flow.

This resistance is 1,000-millionth of an ohm.

For ready reference the units most frequently used in practice are tabulated below, together with their value in C.G.S. absolute units.

Electrical Quantity.	Name of Unit.	Dimensions of Unit.	Value in C.G.S. Units.
Resistance	Ohm	LT^{-1}	10^9 C.G.S. units.
Current	Ampere	$L^{\frac{1}{2}}M^{\frac{1}{2}}T^{-1}$	10^{-1} " "
Electrical pressure	Volt	$L^{\frac{3}{2}}M^{\frac{1}{2}}T^{-2}$	10^8 " "
Energy	Joule	L^2MT^{-2}	10^7 " "
Capacity	Farad	$L^{-1}T^2$	10^{-9} " "
Capacity	Microfarad	....	10^{-15} " "
Power	Watt	L^2MT^{-3}	10^7 " "
Power	Kilowatt	....	10^{10} " "
Work	Watt-hour	....	$10^9 \times 36$ "
Work	Kilowatt-hour	....	$10^{12} \times 36$ "

UNITS OF FORCE, PRESSURE, WORK, POWER.

FORCE.—1 *dyne* = that force which acting on 1 gramme for 1 second gives it a velocity of 1 centimeter per second (being absolute unit of force in the C.G.S. system, independent of local variations of gravity).

1 *gram weight* = at Paris, 980 dynes; at London, 981 dynes; at Glasgow, 982 dynes.

1 *pound weight* = 453.6 grams weight; = at Paris, 444,528 dynes; at London, 444,987 dynes.

PRESSURE.—1 *pound per square inch* = 0.0703 kilogram per square centimeter.

1 *kilogram per square centimeter* = 14.2 lbs. per square inch.

1 *atmosphere* = 30 in. of mercury = nearly 76 centimeters of mercury = nearly 15 lbs. per square inch = nearly 1,000,000 dynes per square centimeter.

The following will serve to illustrate the magnitude of some of these units:

10 ft. of pure copper wire 0.01 in. diameter is almost exactly equal to 1 ohm.

The current used in an ordinary incandescent lamp of 16 candle-power is about 0.6 ampere.

The electrical pressure of the terminals of the cell usually used for electric bells (Leclanche) is about 1.4 volt.

1 watt = about 44¼ foot-lbs. per minute.
746 watts = 1 horse-power.
1 kilowatt = about 1⅓ horse-power.

An easy way to convert watts into the equivalent horse-power is to mark off three places and add one-third: Thus,

What is the equivalent horse-power of 27,000 watts?

Set off three decimal places.........	27.000
Add one-third..................	9.000
And the horse-power required =	36

Find the equivalent number of watts of 48 electrical horse-power?

Multiply the horse-power by 1,000, thus $48 \times 1{,}000$	= 48,000
Subtract one-quarter, $\frac{48000}{4}$	= 12,000
And the required number of watts	= 36,000

RESISTANCE.

CONDUCTORS.—Nearly all substances as they occur in nature conduct electricity—*i.e.*, if the substance is joined to a source of electrical energy, a magnetic field is created around it. Roughly, three groups of conductors may be formed, but of very varying degree: 1st, good conductors, pure metals, and alloys of metals; 2d, at a long interval, solutions of electrolytes—*i.e.*, solutions capable of being decomposed by the passage of an electric current through them; and 3d, very bad conductors, such as India rubber, ebonite, shellac, sulphur, glass, slate, marble, stoneware, mica, dry wood and paper, animal fibers (silk, wool, furs), petroleum oil, paraffin wax, ozokerit, pitch, bitumen; etc. Usually, in practical work, the first class is spoken of as conductors, and the third class as insulators.

RESISTANCE.—The resistance of a conductor is

(*a*) Directly proportional to its length; (*b*) Inversely proportional to its cross-sectional area; (*c*) Directly proportional to its specific resistance; (*d*) and usually increases with its temperature.

SPECIFIC RESISTANCE.—The specific resistance of a substance is usually stated as the resistance between the faces of a cube of the substance, 1 centimeter in length and 1 square centimeter in cross-sectional area.

The law of resistance may be stated thus, neglecting the effect of temperature:

$$R = \frac{\rho l}{s};$$

where
R = the resistance in ohms;
l = the length of conductor;
s = the cross-sectional area of the conductor;
ρ = the specific resistance of the material.

RESISTANCE OF METALS AND ALLOYS (CHEMICALLY PURE) AT 32° F. IN STANDARD OHMS.

Metal.	(ρ) Specific Resistance Cubic Centimeter Microhms.	Resistance per Foot, $\frac{1}{1000}$ Inch Diameter.	Resistance per Meter, 1 Millimeter Diameter.	Relative Resistance.
		Ohms.	Ohms.	
Silver, annealed.........................	1.5006	9.0283	0.01911	1.000
" hard-drawn.........................	1.6298	9.8028	0.02074	1.086
Copper, annealed.........................	1.61966	10.2063	0.02160	1.130
" hard-drawn.........................	1.73054	10.4117	0.02204	1.153
Gold, annealed.........................	2.0531	12.3522	0.02614	1.369
" hard-drawn.........................	2.0896	12.5692	0.0266	1.393
Aluminum, annealed.........................	2.9055	17.4825	0.037	1.935
Zinc, pressed.........................	5.6127	33.7614	0.071	3.741
Platinum, annealed.........................	9.0352	54.3517	0.115	6.022
Iron, annealed.........................	9.6933	58.308	0.123	6.460
Lead, pressed.........................	19.584	117.79	0.249	13.05
German silver, hard or annealed............	20.886	125.62	0.266	13.92
Platinum, silver alloy (2 parts silver and 1 part platinum), hard or annealed.........	24.329	146.36	0.310	16.21
Manganese steel.........................	75	447.50	0.95	49.7
Mercury.........................	96	570.84	1.208	62.73

APPROXIMATE PERCENTAGE VARIATION IN RESISTANCE AT ABOUT 20° C. (68° F.)

Metal or Alloy.	(a) Per 1° C.	(a) Per 1° F.
Platinum Silver (1 pt. Platinum to 2 pts. Silver), hard or annealed	0.031	0.017
German Silver, hard or annealed	0.044	0.024
Mercury	0.072	0.040
Bismuth, pressed	0.354	0.197
Gold, annealed	0.365	0.203
Zinc, pressed	0.365	0.203
Tin, "	0.365	0.203
Silver, annealed	0.377	0.209
Lead, pressed	0.387	0.215
Copper, annealed	0.428	0.238
Iron (about)	0.5	0.278

—*Practical Engineer's Electrical Pocket-Book and Diary.*

HEAT AND ELECTRICAL CONDUCTIVITY.

Substances.	Heat Conductivity.	Electrical Conductivity.
Silver	100.0	100.0
Copper	73.6	73.3
Gold	53.2	58.5
Brass	23.6	21.5
Zinc	19.9	....
Tin	14.5	22.6
Steel	12.0	....
Iron	11.9	13.0
Lead	8.5	10.7
Platinum	6.4	10.3
Palladium	6.3	....
Bismuth	1.8	1.9

RESISTANCE AND WEIGHT TABLE.

American gauge for cotton and silk-covered and bare copper wire.—The resistances are calculated for pure copper wire.

The number of feet to the pound is only approximate for insulated wire.

No.	Diameter.	Feet per Pound.			Resistance, Naked Copper.			
		Cotton Covered.	Silk Covered.	Naked.	Ohms per 1,000 Feet.	Ohms per Mile.	Feet per Ohm.	Ohms per Pound.
8	.12849	....	....	20	.6259	3.3	1600	.0125
9	.11443	....	....	25	.7892	4.1	1272	.0197
10	.10189	....	....	32	.8441	4.4	1185	.0270
11	.09074	....	....	40	1.254	6.4	798	.0501
12	.08081	42	46	50	1.580	8.3	633	.079
13	.07196	55	60	64	1.995	10.4	504	.127
14	.06408	68	75	80	2.504	13.2	400	.200
15	.05707	87	95	101	3.172	16.7	316	.320
16	.05082	110	120	128	4.001	23	230	.512
17	.04525	140	150	161	5.04	26	198	.811
18	.0403	175	190	203	6.36	33	157	1.29
19	.03539	220	240	256	8.25	43	121	2.11
20	.03196	280	305	324	10.12	53	99	3.27
21	.02846	360	390	408	12.76	68	76.5	5.20
22	.02535	450	490	514	16.25	85	61.8	8.35
23	.02257	560	615	649	20.30	108	48.9	13.3
24	.0201	715	775	818	25.60	135	39.0	20.9
25	.0179	910	990	1,030	32.2	170	31.0	33.2
26	.01594	1,165	1,265	1,300	40.7	214	24.6	52.9
27	.01419	1,445	1,570	1,640	51.3	270	19.5	84.2
28	.01264	1,810	1,970	2,070	64.8	343	15.4	134
29	.01126	2,280	2,480	2,617	81.6	432	12.2	213
30	.01002	2,805	3,050	3,287	103	538	9.8	338
31	.00893	3,605	3,920	4,144	130	685	7.7	539
32	.00795	4,535	4,930	5,227	164	865	6.1	856
33	.00708	....	6,200	6,590	206	1033	4.9	1357
34	.0063	....	7,830	8,330	260	1389	3.8	2166
35	.00561	....	9,830	10,460	328	1820	2.9	3521
36	.005	....	12,420	13,210	414	2200	2.4	5469

WEIGHT IN POUNDS PER MILE OF COPPER WIRE.

Number.	Roebling.	Birmingham.	Brown & Sharpe.	English Legal Standard.	Number.	Roebling.	Birmingham.	Brown & Sharpe.	English Legal Standard.
0000	2,466	3,286	3,375	2,555	14	102	110	65	102
000	2,092	2,884	2,677	2,210	15	83	83	52	83
00	1,750	2,305	2,123	1,933	16	64	68	41	65
0	1,504	1,846	1,684	1,682	17	47	53¾	33	50
1	1,278	1,437	1,335	1,437	18	35	38	26	37
2	1,104	1,287	1,058	1,216	19	27	28	20¾	26
3	950	1,071	839	1,012	20	19½	19½	16¼	20¾
4	808	904	665	860	21	16¼	16¼	13	16¼
5	684	773	528	718	22	12½	12½	10¼	12½
6	588	657	418	588	23	10¼	10¼	8⅛	9¼
7	500	517	332	495	24	8¼	7¾	6½	7¾
8	419	435	263	409	25	6½	6½	5⅛	6½
9	350	350	209	332	26	5	5	4	5
10	291	287	166	263	27	4½	4	3¼	4
11	230	230	131	215	28	4	3¼	2½	3½
12	176	190	104	173	29	3⅝	2⅝	2	3
13	135	144	83	135	30	3¼	2¼	1⅝	2½

WIRE GAUGES, IN DECIMAL PARTS OF AN INCH.

Number of Wire Gauge.	Roebling.	Brown & Sharpe.	Birmingham or Stubs.	English Legal Standard.	Old English, or London.
000000	0.46	....	......	0.464	......
00000	0.43	....	......	0.432	......
0000	0.393	0.46	0.454	0.4	0.454
000	0.362	0.40964	0.425	0.372	0.425
00	0.331	0.3648	0.380	0.348	0.38
0	0.307	0.32495	0.340	0.324	0.34
1	0.283	0.2893	0.3	0.3	0.3
2	0.263	0.25763	0.284	0.276	0.284
3	0.244	0.22942	0.259	0.252	0.259
4	0.225	0.20431	0.238	0.232	0.238
5	0.207	0.18194	0.22	0.212	0.22
6	0.192	0.16202	0.203	0.192	0.203
7	0.177	0.14428	0.18	0.176	0.18
8	0.162	0.12849	0.165	0.16	0.165
9	0.148	0.11443	0.148	0.144	.148
10	0.135	0.10189	0.134	0.128	0.134
11	0.12	0.09074	0.12	0.116	0.12
12	0.105	0.08081	0.109	0.104	0.109
13	0.092	0.07196	0.095	0.092	0.095
14	0.08	0.06408	0.083	0.08	0.083
15	0.072	0.05706	0.072	0.072	0.072
16	0.063	0.05082	0.065	0.064	0.065
17	0.054	0.04525	0.058	0.056	0.058
18	0.047	0.0403	0.049	0.048	0.049
19	0.041	0.03589	0.042	0.04	0.04
20	0.035	0.03196	0.035	0.036	0.035
21	0.032	0.02846	0.032	0.032	0.0315
22	0.028	0.02534	0.028	0.028	0.0295
23	0.025	0.02257	0.025	0.024	0.027
24	0.023	0.0201	0.022	0.022	0.025
25	0.02	0.0179	0.02	0.02	0.023
26	0.018	0.01594	0.018	0.018	0.0205
27	0.017	0.01419	0.016	0.0164	0.01875
28	0.016	0.01264	0.014	0.0148	0.0165
29	0.015	0.01125	0.013	0.0136	0.0155
30	0.014	0.01002	0.012	0.0124	0.01375
31	0.0135	0.00893	0.010	0.0116	0.01225
32	0.013	0.00795	0.009	0.0108	0.01125
33	0.011	0.00708	0.008	0.01	0.01025
34	0.01	0.0063	0.007	0.0092	0.0095
35	0.0095	0.00561	0.005	0.0084	0.009
36	0.009	0.005	0.004	0.0076	0.0075

TABLE INDICATING SIZE, WEIGHT, AND LENGTH OF IRON AND STEEL WIRE.

Gauge Numbers.	Diameter, Ins.	W'ight of 100 Feet. Lbs.	W'ight of One Mile, Lbs.	Feet in 2000 Lbs.	Area, Square Ins.
3–0	.362	34.73	1834	5,759	.102921
2–0	.331	29.04	1533	6,886	.086049
1–0	.307	25.00	1318	8,000	.074023
1	.283	21.23	1121	9,425	.062901
2	.263	18.34	968	10,905	.054325
3	.244	15.78	833	12,674	.046759
4	.225	13.39	707	14,936	.039760
5	.207	11.35	599	17,621	.033653
6	.192	9.73	514	20,555	.028952
7	.177	8.30	439	24,906	024605
8	.162	6.96	367	28,734	.020612
9	.148	5.80	306	34,483	.017203
10	.135	4.83	255	41,408	.014313
11	.120	3.82	202	52,356	.011309
12	.105	2.92	154	68,493	.008659
13	.092	2.24	118	89,286	.006647
14	.080	1.69	89	118,343	.005026
15	.072	1.37	72	145,985	.004071
16	.063	1.05	55	190,476	.003117
17	.054	0.77	41	259,740	.002290
18	.047	0.58	31	344,827	.001734
19	.041	0.45	24	444,444	.001320
20	.035	0.32	17	625,000	.000962
21	.032	0.27	14	740,741	.000804
22	.028	0.21	11	952,381	.000615
23	.025	0.175	9.24	......	.000491
24	.023	0.140	7.39	......	.000415
25	.020	0.116	6.124	......	.000314
26	.018	0.093	4.91	......	.000254
27	.017	0.083	4.382	......	.000227
28	.016	0.074	3.907	......	.000201
29	.015	0.061	3.22	......	.000176
30	.014	0.054	2.851	......	.000154
31	.0135	0.050	2.64	......	.000143
32	.013	0.046	2.428	......	.000132
33	.011	0.037	1.953	......	.000095
34	.010	0.030	1.584	......	.000078
35	.0095	0.025	1.32	......	.000071
36	.009	0.021	1.161	......	.000064

ELECTRICAL HORSE-POWER.

Calculated from $\frac{E \times C}{746}$.

Current in Amperes.	E.M.F. in Volts.														
	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
5	0.06	0.13	0.20	0.28	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.0
10	0.13	0.28	0.40	0.53	0.67	0.80	0.93	1.07	1.2	1.3	1.4	1.6	1.6	1.9	2.0
20	0.28	0.53	0.80	1.07	1.3	1.6	1.9	2.1	2.4	2.7	2.9	3.2	3.5	3.7	4.0
30	0.40	0.80	1.2	1.6	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0
40	0.53	1.07	1.6	2.1	2.6	3.2	3.7	4.2	4.8	5.3	5.9	6.4	6.9	7.5	8.0
50	0.67	1.30	2.0	2.6	3.3	4.0	4.6	5.4	6.0	6.7	7.4	8.0	8.7	9.4	10.0
60	0.80	1.6	2.4	3.2	4.0	4.8	5.6	6.4	7.2	8.0	8.8	9.6	10.4	11.2	12.0
70	0.93	1.9	2.8	3.7	4.6	5.6	6.5	7.5	8.4	9.4	10.3	11.2	12.3	13.1	14.0
80	1.07	2.1	3.2	4.2	5.4	6.4	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.0
90	1.2	2.4	3.6	4.8	6.0	7.2	8.4	9.6	10.8	12.0	13.2	14.4	15.6	16.9	18.0
100	1.3	2.7	4.0	5.3	6.7	8.0	9.4	10.7	12.0	13.4	14.7	16.0	17.4	18.7	20.0
110	1.4	2.9	4.4	5.9	7.4	8.8	10.3	11.8	13.2	14.7	16.2	17.6	19.1	20.6	22.0
120	1.5	3.2	4.8	6.4	8.0	9.6	11.2	12.8	14.4	16.0	17.6	19.2	20.9	22.5	24.0
130	1.6	3.5	5.2	6.9	8.7	10.4	12.3	13.9	15.6	17.4	19.1	20.9	22.6	24.4	26.0
140	1.9	3.7	5.6	7.5	9.4	11.2	13.1	15.0	16.9	18.7	20.6	22.5	24.4	26.2	28.0
150	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0	22.0	24.0	26.0	28.0	30.0

E.H.P. on current line, under E.M.F.

COMPOSITION AND ELECTROMOTIVE FORCE OF BATTERY CELLS.

Name.	Electrodes.	Solutions.	E.M.F.
Clark.	Pure mercury and pure zinc.	The mercury is covered with a paste of mercurous sulphate and a saturated solution of zinc sulphate, in which is placed the rod of zinc.	1.434 at 15° C. at any temp t° C. it is $1.434[1-.0008(t^{\circ}-15^{\circ})]$.
Daniell.	Copper and zinc.	The zinc is immersed in a solution of zinc sulphate, and the copper in a solution of copper sulphate.	Depends upon the densities of the solutions; it varies from 1.07 to 1.14 volts.
Groves.	Platinum and zinc.	The platinum is immersed in a strong nitric acid, and the zinc in dilute sulphuric acid.	About 1.93 volts.
Bunsen.	Carbon and zinc.	The carbon in nitric acid, and the zinc in dilute sulphuric acid.	About 1.74 volts.
Leclanche.	Carbon and zinc.	The carbon is packed in a porous pot with peroxide of manganese and broken gas carbon. The zinc is immersed in solution of sal ammoniac.	About 1.47 volts; but is quickly reduced if used to send a strong current.
Potash-bichromate.	Carbon and zinc.	The best solution is 1 lb. of potassium-bichromate, 2 lbs. strong sulphuric acid sp. gr. 1.836, and 12 lbs. water, in which both electrodes are immersed, the zinc being withdrawn when the cell is not in use.	About 2 volts; but is quickly reduced if employed to send a strong current.

—Practical Engineers' Electrical Pocket Book.

STANDARD TABLE OF HEIGHT AND WEIGHT.

Height.	Weight.		
	Maximum.	Standard.	Minimum.
4 feet 10 inches	150	105	83
4 " 11 "	160	110	87
5 "	167	115	92
5 " 1 "	174	120	96
5 " 2 "	181	125	100
5 " 3 "	188	130	104
5 " 4 "	195	135	108
5 " 5 "	200	140	112
5 " 6 "	205	145	115
5 " 7 "	210	150	120
5 " 8 "	215	155	125
5 " 9 "	220	160	130
5 " 10 "	225	165	135
5 " 11 "	230	170	140
6 "	235	175	145
6 " 1 "	240	180	150
6 " 2 "	245	185	155
6 " 3 "	250	190	160
6 " 4 "	255	195	165

—Table furnished by F. L. Hoffman, Insurance Statistician.

THE AMERICAN EXPERIENCE TABLE OF MORTALITY.

Age.	Expectation of Life in Years.	Number Dying in Each 1,000.	Age.	Expectation of Life in Years.	Number Dying in Each 1,000.
20	42.20	7.81	60	14.10	26.69
21	41.53	7.86	61	13.47	28.88
22	40.85	7.91	62	12.86	31.29
23	40.17	7.96	63	12.26	33.94
24	39.49	8.01	64	11.67	36.87
25	38.81	8.07	65	11.10	40.13
26	38.12	8.13	66	10.54	43.71
27	37.43	8.20	67	10.00	47.65
28	36.73	8.26	68	9.47	52.00
29	36.03	8.35	69	8.97	56.76
30	35.33	8.43	70	8.48	61.99
31	34.63	8.51	71	8.00	67.67
32	33.92	8.61	72	7.55	73.73
33	33.21	8.72	73	7.11	80.18
34	32.50	8.83	74	6.68	87.03
35	31.78	8.95	75	6.27	94.37
36	31.07	9.09	76	5.88	102.31
37	30.35	9.23	77	5.49	111.06
38	29.62	9.41	78	5.11	120.83
39	28.90	9.59	79	4.74	131.73
40	28.18	9.79	80	4.39	144 47
41	27.45	10.01	81	4.05	158.61
42	26.72	10.25	82	3.71	174.30
43	26.00	10.52	83	3.39	191.56
44	25.27	10.83	84	3.08	211.36
45	24.54	11.16	85	2.77	235.55
46	23.81	11.56	86	2.47	265.68
47	23.08	12.00	87	2.18	303.02
48	22.36	12.51	88	1.91	346.69
49	21.63	13.11	89	1.66	395.86
50	20.91	13.78	90	1.42	454.55
51	20.20	14.54	91	1.19	532.47
52	19.49	15.39	92	.98	634.26
53	18.79	16.33	93	.80	734.18
54	18.09	17.40	94	.64	857.14
55	17.40	18.57	95	.50	1000.00
56	16.72	19.89			
57	16.05	21.34			
58	15.39	22.94			
59	14.74	24.72			

THE AMOUNT OF ONE DOLLAR AT COMPOUND INTEREST.

End of Year.	3 Per Cent.	3½ Per Cent.	4 Per Cent.	4½ Per Cent.	5 Per Cent.	6 Per Cent.	7 Per Cent.
1	$1.03	$1.04	$1.04	$1.05	$1.05	$1.06	$1.07
2	1.06	1.07	1.08	1.09	1.10	1.12	1.14
3	1.09	1.11	1.12	1.14	1.16	1.19	1.23
4	1.13	1.15	1.17	1.19	1.22	1.26	1.31
5	1.16	1.19	1.22	1.25	1.28	1.34	1.40
6	1.19	1.23	1.27	1.30	1.34	1.42	1.50
7	1.23	1.27	1.32	1.36	1.41	1.50	1.61
8	1.27	1.32	1.37	1.42	1.48	1.59	1.72
9	1.30	1.36	1.42	1.49	1.55	1.69	1.84
10	1.34	1.41	1.48	1.55	1.63	1.79	1.97
11	1.38	1.46	1.54	1.62	1.71	1.90	2.10
12	1.43	1.51	1.60	1.70	1.80	2.01	2.25
13	1.47	1.56	1.67	1.77	1.89	2.13	2.41
14	1.51	1.62	1.73	1.85	1.98	2.26	2.58
15	1.56	1.68	1.80	1.94	2.08	2.40	2.76
16	1.60	1.73	1.87	2.02	2.18	2.54	2.95
17	1.65	1.79	1.95	2.11	2.29	2.69	3.16
18	1.70	1.86	2.03	2.21	2.41	2.85	3.38
19	1.75	1.92	2.11	2.31	2.53	3.03	3.62
20	1.81	1.99	2.19	2.41	2.65	3.21	3.87
21	1.86	2.06	2.28	2.52	2.79	3.40	4.14
22	1.92	2.13	2.37	2.63	2.93	3.60	4.43
23	1.97	2.21	2.46	2.75	3.07	3.82	4.74
24	2.03	2.28	2.56	2.88	3.23	4.05	5.07
25	2.09	2.36	2.67	3.01	3.39	4.29	5.43
26	2.16	2.45	2.77	3.14	3.56	4.55	5.81
27	2.22	2.53	2.88	3.28	3.73	4.82	6.21
28	2.29	2.62	3.00	3.43	3.92	5.11	6.65
29	2 36	2.71	3.12	3.58	4.12	5.42	7.11
30	2.43	2.81	3.24	3.75	4.32	5.74	7.61
31	2.50	2.91	3.37	3.91	4.54	6.09	8.15
32	2.58	3.01	3.51	4.09	4.76	6.45	8.72
33	2.65	3.11	3.65	4.27	5.00	6.84	9.33
34	2.73	3.22	3.79	4.47	5.25	7.25	9.98
35	2.81	3.33	3.95	4.67	5.52	7.69	10.68
36	2.90	3.45	4.10	4.88	5.79	8.15	11.42
37	2.99	3.57	4.27	5.10	6.08	8.64	12.22
38	3.07	3.70	4.44	5.33	6.39	9.15	13.08
39	3.17	3.83	4.62	5.57	6.70	9.70	13.99
40	3.26	3.96	4.80	5.82	7.04	10.29	14.97
41	3.36	4.10	4.99	6.08	7.39	10.90	16.02
42	3.46	4.24	5.19	6.35	7.76	11.56	17.14
43	3.56	4.39	5.40	6.64	8.15	12.25	18.34
44	3.67	4.54	5.62	6.94	8.56	12.99	19.63
45	3.78	4.70	5.84	7.25	8.99	13.76	21.00
46	3.90	4.87	6.07	7.57	9.43	14.59	22.47
47	4.01	5.04	6.32	7.92	9.91	15.47	24.05
48	4.13	5.21	6.57	8.27	10.40	16.39	25.73
49	4.26	5.40	6.83	8.64	10.92	17.38	27.53
50	4.38	5.58	7.11	9.03	11.47	18.42	29.46

ROMAN NOTATION.

1 = I.
2 = II.
3 = III.
4 = IV.
5 = V.
6 = VI.
7 = VII.
8 = VIII.
9 = IX.
10 = X.
20 = XX.
30 = XXX.
40 = XL.
50 = L.
60 = LX.
70 = LXX.
80 = LXXX.
90 = XC.
100 = C
500 = D, or IƆ.
1,000 = M, or CIƆ.
2,000 = MM, or IIƆƆƆ.
5,000 = $\overline{V}$, or IƆƆ.
6,000 = $\overline{VI}$, or MMM.
10,000 = $\overline{X}$, or CCIƆƆ.
50,000 = $\overline{L}$, or IƆƆƆ.
60,000 = $\overline{LX}$, or MMMƆ.
100,000 = $\overline{C}$, or CCCIƆƆƆ.
1,000,000 = $\overline{M}$, or CCCCIƆƆƆƆ.
2,000,000 = $\overline{MM}$, or MMƆƆƆ.

A line over a number increases it 1,000 times.

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